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AIR BASES

VOLUME VI 11 1951

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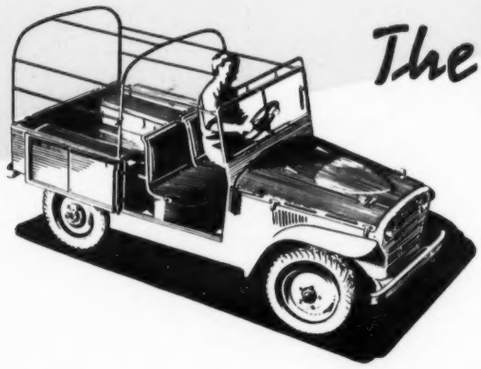

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Review of World Aviation

Volume VI — No 11 — 1951

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Front cover :

High-speed jet-propelled bombers like the six-engined Boeing B-47 "Stratojet" necessitate the maintenance of air bases within relatively short striking distance of the potential target area.

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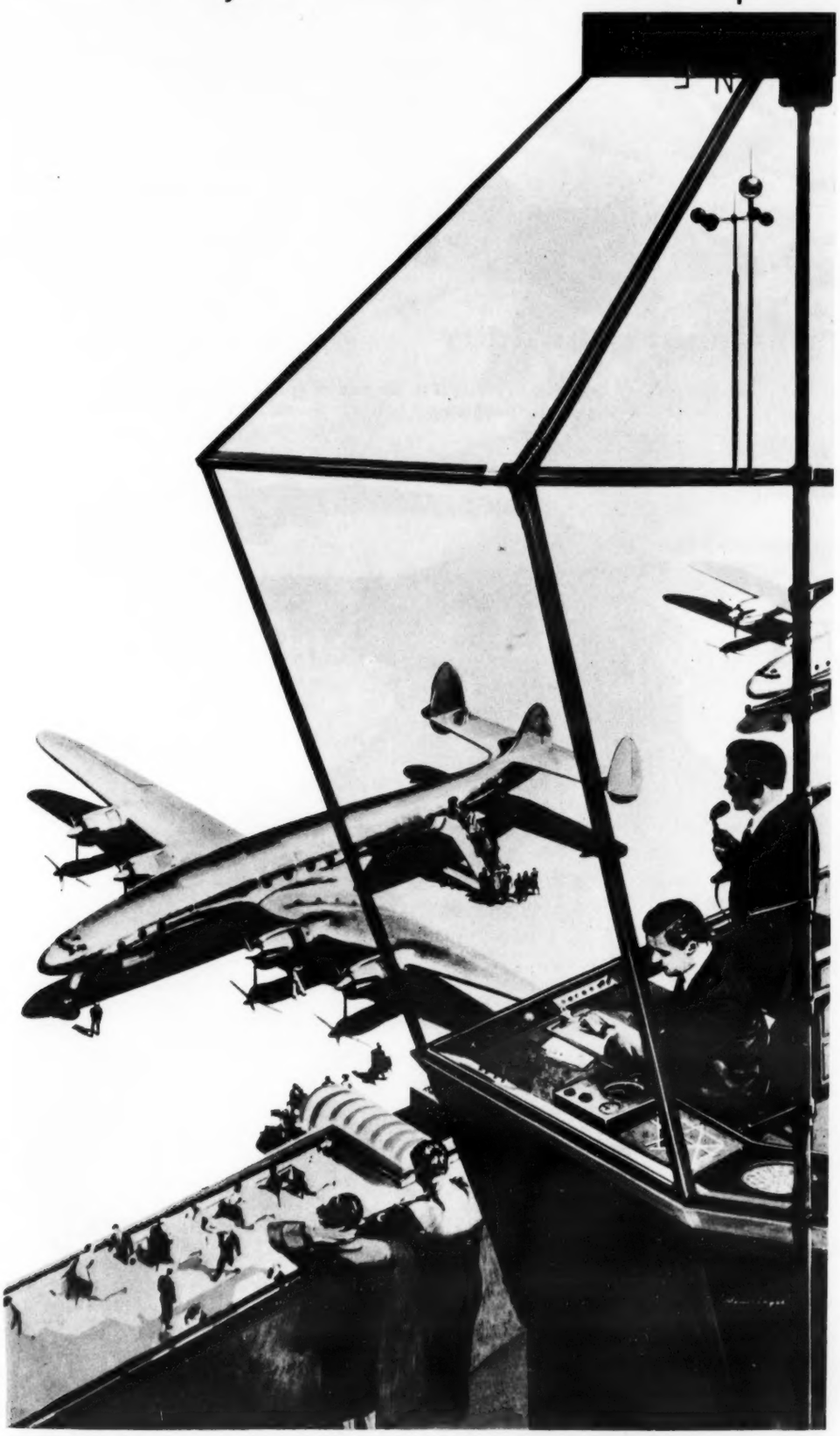

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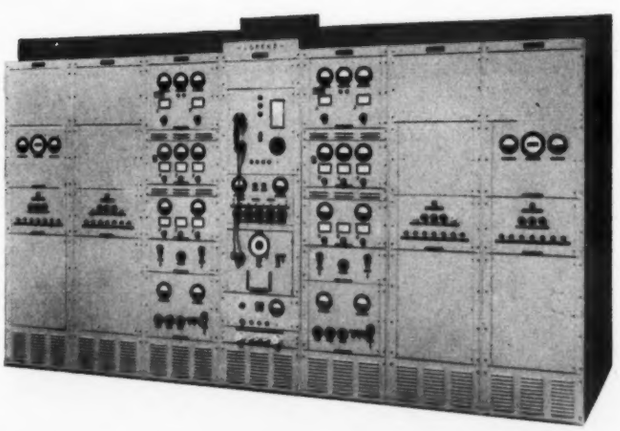

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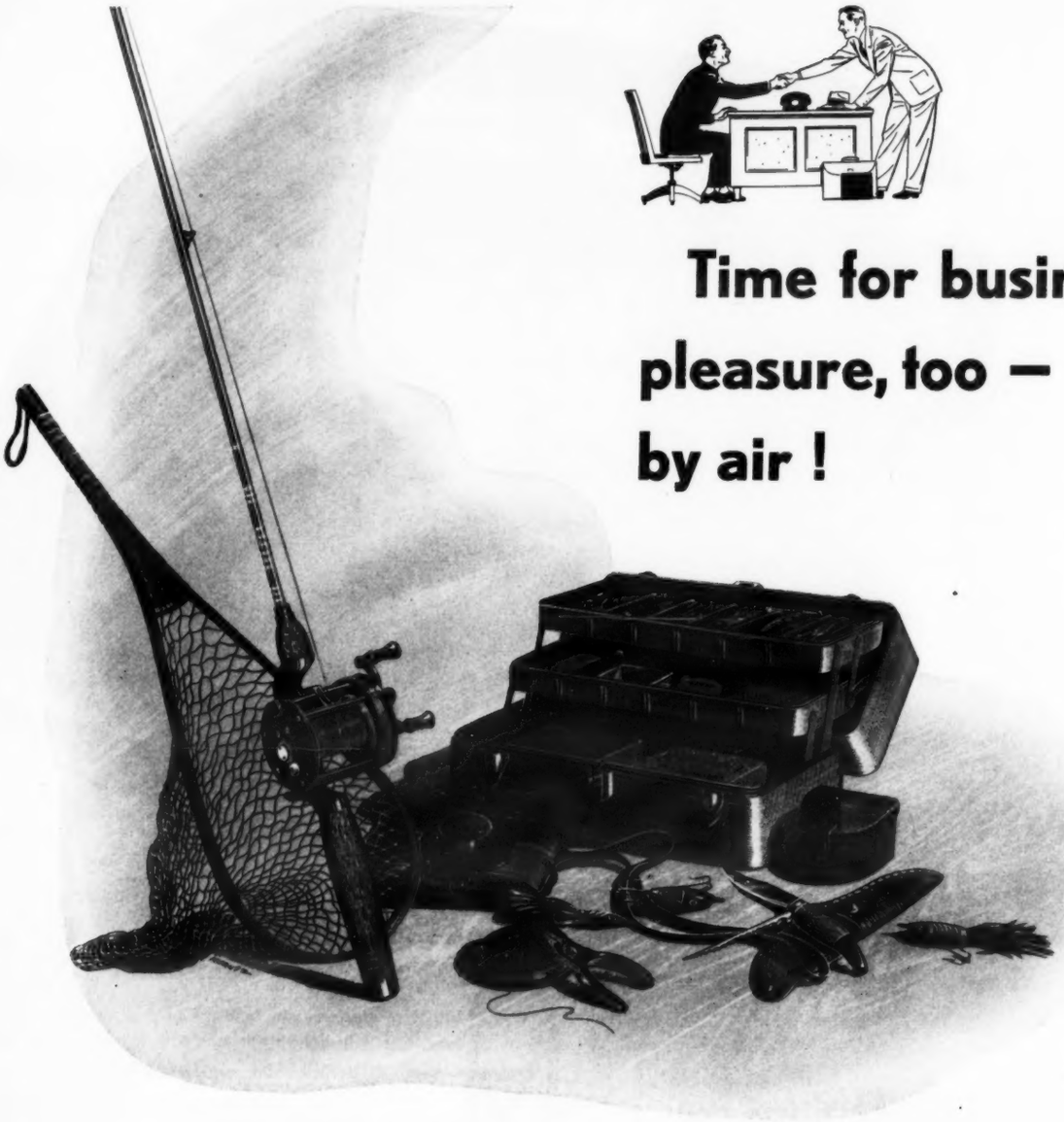

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Air Bases

PAX AMERICANA?

U.S. Air Bases throughout the World

Playing with figures

The Americans can claim a victory on the psychological front of the cold war. The Russian press has succumbed to the "numbers racket" which has hitherto been regarded as a typical American pastime. On July 29th, 1951, the "New York Times" published a map of American air bases. A fortnight later the Moscow six-language weekly, "New Times," complained bitterly that the information published was quite misleading, since for example there was no mention in the map of Formosa, Hawaii, Norway or Austria. The map showed 85 bases, but in actual fact the U.S.' own Air Force Secretary had stated officially that there were 232 and that this number was shortly to be increased to 309.

Unlike certain other U.S.-Russian differences of opinion, this one can be cleared up without much trouble. It is true that Secretary Thomas K. Finletter had mentioned the figure 232 to the U.S. Congress, but he had expressly emphasized that this figure referred to both overseas *and* continental U.S. bases. On the other hand the map in the "New York Times" showed only the foreign bases, on whose number and location Finletter had not commented.

Those who like figures can find even higher estimates. For example, a certain French military journal ("Revue de défense nationale," October, 1950 : Jean Chardonnet, "La politique américaine des bases aériennes et navales") declares that the U.S. had 925 air bases at the end of the war and had largely retained the contractual right to use them.

When it comes down to it this playing with figures is somewhat futile, particularly as the American system of bases is growing from month to month. The only really interesting fact is that America has been jolted out of her Olympian calm by the landslide of events and has been forced against her will to establish herself around the world.

The Monroe Doctrine

The United States entered the twentieth century as a purely continental power with no overseas possessions to speak of. Even Lenin could at that time find no "colonial sins" to reproach the Americans with. In his pamphlet, "Imperialism, the latest phase of capitalism," published in 1917, he classified the Colonial Powers of that time in the following order :

Colonial possessions in 1914 in million sq.miles and million inhabitants.

	sq.miles	*population*
Britain	12.8	393.5
Russia	6.7	33.2
France	4.1	55.5
Germany	1.1	12.3
USA	0.1	9.7

In foreign policy the U.S. was still adhering to the hundred-year-old Monroe Doctrine, the principle laid down by President James Monroe, which was primarily directed against intervention on the Continent of America ("America for the Americans"), but was also accompanied by the recommendation that the USA, for its part, should keep out of other countries' affairs.

When considering the needs of military security, the U.S. General Staff started from three basic assumptions : 1) complete improbability of an attack from North or East ; 2) necessity of protecting the Panama Canal ; 3) possibility of Japanese naval operations from the West. It therefore appeared that two chains of bases would be sufficient, the one on the continent itself, along the west coast from Seattle in the north through San Francisco to San Diego in the south. The other, in front of the first, included strong points in the Aleutians (in particular Dutch Harbour), Hawaii and the "five-mile zone" on either side of the Panama Canal (with outlying island bastions such as Puerto Rico, Virgin Islands, etc.). Finally, there were in the Western Pacific, more or less isolated among Japanese possessions, the American islands of Wake, Guam and the Philippines.

Growing need for security

World War II brought a rude awakening from this "dream of continental American security." German long-range U-boats sank American tankers in the Caribbean. In the Pacific the Japanese air raid on Pearl Harbour and subsequent *blitz* on the American island possessions proved that even the largest ocean was no longer capable of providing adequate protection against modern air fleets. From 1939 onwards the Atlantic was regularly

The America of the Monroe Doctrine. Up to World War II the Americans managed with a "narrow defence belt": *along the West coast* from Seattle to San Diego ; *advance posts :* Aleutians, Hawaii ; *in the South :* "five-mile zone" of the Panama Canal, Puerto Rico, etc. *Broken line* encloses guarantee zone of Pan American Security Pact of Rio de Janeiro (September 2nd, 1947). The line in the North indicates the *first chain of overseas bases* established during World War II : Baffin Island, Newfoundland, Greenland, Iceland.

Running an Arctic air base is no child's play : digging out the jet fighters during the U.S.-Canadian "Exercise Sweetbriar."

crossed by transport aircraft. And another disturbing fact was that even the eternal ice of the Polar regions ceased to be a hindrance to air operations. Although they were at that time allies of the U.S., the Russians made north east Siberia into an air base and firmly refused to permit the American aircraft supplied under Lease-Lend to fly over Siberia. Russian pilots were sent to Fairbanks (Alaska) to fetch the flying equipment.

There was only one answer to all these problems : air bases, and plenty of them, with safe lines of communication with the supply bases in the U.S. From the geographical point of view the execution of this programme of bases was determined by the progress of the war. In the Pacific, where the American forces were battling forward from island to island, construction troops followed close on the landing units, and the Japanese bases were annexed. In the Atlantic the position was somewhat different. There, it is true, there were U-boats and German aircraft, but no "enemy territory." All the islands in the Atlantic belonged to Allied or neutral powers. Rights on them could only be obtained by concluding treaties.

Nevertheless, the need for Atlantic bases was no smaller than for the Pacific. The Air Transport Command of the U.S. Army and the Royal Canadian Air Force had to fly the bombers and heavy transports for the European theatre to England and needed landing bases in the Azores, Greenland and Iceland. The agreements signed then were very carefully worded, were kept within the bounds of the traditional international lease agreements and gave the Americans (the installations in Iceland were leased by the British) rights, which were as a rule strictly limited in time and space, to construct the absolutely essential ground installations. The sovereignty of the possessor States remained inviolate. A typical example is the Anglo-American bases agreement of September 2nd, 1940 (extended on March 27th, 1941), under which the U.S. exchanged 50 destroyers for nine British bases in Newfoundland and the Caribbean (Trinidad, Bermuda, bahamas, Antigua, Santa Lucia, Jamaica, British Guiana). In practice the Americans had nothing to do with the civil administration of these territories. The State Department even had to conduct an extensive correspondence with Churchill to avoid American mail between Bermuda and the U.S. having to pass through the British censorship.

*

Needless to say the Americans were not only collecting "international" experience in the operation of bases, but were also paying the price of learning to run their ground organization in the tropics and the Arctic, a heavy price, which is now showing dividends in more than one respect in today's intercontinental traffic. On the Equator they battled with tropical heat which reduced the take-off power of engines and necessitated the building of longer runways. Runways crumbled under the sharp differences between night and day temperatures in the desert, and were pierced and broken up by the giant force of spreading tree roots in tropical forest areas.

North of the Polar circle they were obliged to employ weather ships, since the meteorological service in the Arctic was very weak up to well after the war. Equipment had to be handled at temperatures of minus 40 degrees and below, temperatures at which tyres burst as the aircraft landed, fuel ceased to evaporate and lubricant froze in the pipes. Any buildings not constructed on grids were swallowed up by the mud when the snow thawed ; roads disappeared if not constantly worked on. And if a mechanic touched a piece of metal with his bare hand his skin stuck to it.

When the Germans and the Japanese capitulated the Americans had not only acquired several hundred air bases throughout the world. They had learned to use them and—an important point for the future—to appreciate their true value to American aviation.

*

The war was over. The USAF sold its surplus aircraft and put those with which it did not definitely wish to part into mothballs. Many of the base agreements ran out and the airfields, when the Americans had left, were handed over to civil aviation in the owner countries. But these were by no means all. In the Pacific, for example, the situation remained unchanged. The Carolines, Palau, the Marshalls, Bonin, in short 1400 former Japanese islands covering 850 square miles and with a population of 120,000 were placed under the trusteeship of the U.S. by the United Nations. This, however, was but a temporary arrangement, since on April 2nd, 1947, the U.S. declared the whole of its island possessions in the Pacific a "strategic aera," thus withdrawing them from U.N. control, and decreed that no aircraft might fly over the area without prior permission from the U.S. control authorities.

In the Atlantic, too, the U.S. Air Force still had the sole use of a number of valuable airfields by virtue of long-term agreements.

The U.S.' present air base system.—A : Bases under the Atlantic Pact : Newfoundland, Greenland, Iceland, Britain, France, Belgium, Germany, Austria, Azores, Morocco.—*P :* The Pacific chain : Hawaii, Wake, Midway, Guam, Japan, Korea, Formosa, the Philippines and the former Japanese island possessions.—*ME :* The "petroleum route" to the Middle East : provisionally Tripoli and Dhahran.

Opposition by the isolationists

The relaxation of tension after the war was of short duration. Attempts to reconcile East and West failed, and the nations became aware, as early as the summer of 1947, that the world was still in arms. In this uncomfortable atmosphere the U.S. remembered the Monroe Doctrine again. With eighteen other American countries it signed a Pan-American security pact at Rio de Janeiro on September 2nd, 1947, which provided for mutual assistance and the guaranteeing of the territorial integrity of all the American nations. Later, on March 17th, 1948, delegates from Britain, France and the three Benelux countries met in Brussels to draw up a similar regional pact for Western Europe.

However, the statesmen concerned were agreed, even before these security agreements were ratified, that the new situation could not be met by regional pacts. Once more it was essential for the whole of the Western world to band together, and once more the U.S. was called upon to take the lead. Marshall plan for Europe, Atlantic pact, arms aid agreements, negotiations for security pacts in the southern Pacific and in the Mediterranean area, creation of an Atlantic army under the command of General Eisenhower... the Americans had reluctantly to resume once more the load they had laid down a few years before, and this time their obligations have become gigantic.

For the bases of World War II had become "base areas and base continents" in this age of the atom bomb—hedgehog positions of tremendous proportions which in the event of war would house not only the fighting forces, but also the supply organization and armament industry. To give an idea of the size of these "bases," a French military writer speaks of areas as big as eight or nine French Departments. He considers that these "base regions" should have ports with oil refineries, pipelines, underground factories, etc. (Lieut.-Colonel Dullin, Revue de défense nationale, August-September, 1950, p. 150 et seq.). He shows that, for example, the whole of Western Germany would have to become a kind of air escarpment for the 3750-mile axis running from Dunkirk to French Equatorial Africa, to create a reasonably safe assembly area for the Atlantic army.

No, no, no, cried the American isolationists. The whole policy of bases is a thorn in their flesh. Every two or three months their spokesman, Senator Robert Taft, repeats his old demand: the U.S. should put the Atlantic Pact on ice, cut down its obligations in Europe, Africa and Asia, reduce American land forces to the minimum... and instead of all this build up a strategic long-range bomber force of tremendous power and throw the closest possible air defence network around the American continent.

The isolationists argue that the fortification of Alaska to provide an air shield for northern America, and the securing of bases in the Caribbean so as to guarantee the unhampered importation of raw materials from the south are clearly defined objectives whose implications can be equally clearly foreseen. But the moment the U.S. set up a chain of bases, say in North Africa, it would be taking upon itself all the headaches of local politics. It was inconceivable that America should become involved in European dealings with the Sultanate of Morocco, be saddled with the pacification of the Arab nations in the Middle East or be implicated in the Anglo-Egyptian Sudan conflict or the problem of Northern Ireland.

Such objections are not so far-fetched as would appear at first sight. The average American has recently seen a good example of these problems in the Anglo-Iranian oil conflict. His newspapers have given him almost hourly coverage of the various phases of the negotiations, and the difficulties experienced by the American observer, Averell Harriman. He will doubtless think seriously when he reads in the British press that the British in Egypt regularly receive anxious enquiries from their relatives about their safety and are admonished to act carefully and with reserve, whatever they do.

Many an American taxpayer may be attracted by the isolationists' programme. He will have regarded with mixed feelings the millions of dollars over and above the budget, appropriated by the Senate on September 5th, for the construction of bases (altogether $5,887,669,800; of this $3,567,029,800, including roughly a million dollars for "secret projects" in Europe, North Africa and the Mediterranean, was for the USAF).

Aims of base policy?

Nevertheless the majority of Americans have not been able to accept the isolationists' proposals. The U.S. system of bases is now expanding at an ever-increasing pace. During the last three or four months alone agreements have been made with the Philippines, Japan, France (Morocco), Portugal (Azores), Denmark (Greenland) and Iceland, and on September 20th the Atlantic Council, meeting in Ottawa, agreed on the provision of a further 30 bases for U.S. jet fighters and fighter-bombers on French and Belgian territory.

Why? Is the U.S. setting out to conquer the world, to found an Empire? History might suggest this to be the case. After the Treaty of Utrecht in the early 18th century, the map

The Americans as "colonizers": a MATS instructor teaching Arab ground personnel at Dhahran base.

of the British Empire showed only a few bases, huddled together in a very small space: three British trading posts on the west coast of Africa, three in India. In addition Gibraltar, Malta, a handful of islands in the Caribbean, a narrow strip of coast in North America, a foothold in Nova Scotia and Newfoundland... *Two hundred years later the British Empire was an established entity.*

Does the establishment of U.S. bases today herald a similar development? For example the alliance concluded with the Philippines in August 1951 under which the Americans are empowered not only to increase their existing 16 air bases by 14, but also to recruit volunteers from among the Philippine population and to take over the military administration of the Philippines?

Or the security pact with Japan, signed immediately after the peace treaty, giving the U.S. the right to station army, navy or air force units at any point in or near Japan, to take any measures necessary to maintain internal security and order, in brief to behave in every respect as if it were on American soil?—These rights are to be virtually unlimited in time, since the treaty is not to expire until "in the view of both governments, conditions are such that peace and security are finally assured in the Japanese zone."

The beginnings of an American empire? Most unlikely. Up to the present the Americans have never shown any inclination to play the rôle of colonizers. It is scarcely likely that they would have given the Philippines their independence at the end of World War II, for example, if they intended to swallow them up again five years later, that they would voluntarily have evacuated a thousand and one islands if their plans had been to annex them once and for all, so soon afterwards.

What does the USAF want then? It is not so much a question of what it wants, but of what it has to do.

Air Bases

Return to Short-Range Strategy

The Convair B-36 is a heavy bomber designed to carry atomic bombs over considerable distances. The B-36D version (six piston engines and four jets); speed 435 m.p.h., range exceeding 10,000 miles, 10,000 lbs. of bombs.

Mounting Speeds Outdate Strategic Bombing Concept

BY LIEUT.-COL. PIERRE M. GALLOIS, PARIS

In discharging its atomic load on Hiroshima the American strategic bomber force not only provided an illustration of a new concept of aerial warfare. When Colonel Tibbets took off from the island of Tinian in the *Enola-Gay,* his machine big with the most powerful explosive ever used, he did not suspect that his mission was to shatter the balance of world forces, create a new strategy—and determine its counter-measures—and inaugurate the era of this strange peace, with its hundred threatening facets, which we are experiencing today. Little did he realize that in dropping his load he was setting in motion a cycle which was to lead the American armed forces via a return to home territory, a hasty demobilization and the concept of long-range strategic defence, full circle back to the point they occupied at the end of the last war. Moreover, it is not so much this course of events in itself which is so unusual, but the fact that, in the disordered rhythm of life today, it has taken place in less than a tenth or a twelfth of a man's life... Hence the surprise, nay the lack of comprehension, manifested by a generation which is constantly being outstripped by the repercussions of its own works.

Describing his concept of aerial supremacy obtained with long-range forces, Alexander de Seversky had already stressed the gulf existing between the attitude of the strategists and the rapid transformation of the weapons at their disposal. "Our present military programme" (1943), wrote Seversky, "is founded on a number of doctrines which have the prestige of old age and live on the glories of the past... Now, for our own future and that of humanity, we must revise these concepts in the light of the new conditions of the battle we are waging." These words, applied in a different sense, are equally valid when it comes to reconsidering the problem of the long-distance strategy of which the author of *Victory through Air Power* and *Air Power: Key to Survival* has never ceased to be the advocate. Doubtless, having been true yesterday, the thesis will be true again tomorrow—temporarily, when the real instruments of decisive long-range combat have been produced and the resources of the defence momentarily overtaken. Such is the curve representing the value of a doctrine whose effects are by turn decisive and contestable, according to the technical progress of the moment and the efficacy of the counter-measures prepared against it.

*

Following on the hard campaign in the Pacific and the conquest, island by island, of the route across the ocean, the rapid surrender of Japan confirmed the omnipotence of the atomic bomb and the efficacy of the aircraft which had delivered it. Pearl Harbour, Manila, Hong Kong, Singapore, Corregidor, Java had marked the path of retreat, if not of defeat. And though in the opposite direction Port Moresby, Rabaul, Morotai, Guam, Palau and finally Manila, Tinian and Okinawa marked the stages in the progressive investment of the enemy mainlands, the *Enola-Gay's* flight symbolized the almost instantaneous victory of technical equipment over a people through the sudden destruction of its will to resistance. Although the one strategy had to precede the other, the advantages of the second over the first were obvious. For a nation isolated by two oceans from the centuries-old centres of unrest and wars, long-distance intervention, without intermediate bases to conquer or to defend, became an attractive goal which was all the more accessible and rational since the nation in question at that time possessed the double monopoly of the atomic bomb and the industrial potential required for the production of an aircraft capable of carrying the bomb a quarter way round the world.

In the military domain, this idea of technical superiority could best be expressed by creating a stock of atomic bombs and by the quantity production of a very heavy aircraft, to which the adversary could offer no reply because of its complexity and cost. Adapting to the military field the industrial concept of machines

replacing men, it was natural for the U.S. to take full advantage of their as yet unequalled technical potential.

Peace at home

To a people thirsting for peace and desirous of resuming as rapidly as possible its efforts towards the improvement of its conditions of life without having to worry about the military burdens common to nations more exposed geographically and less favoured industrially, peace obtained through air power and, if necessary, retaliation by a handful of experts wielding the "atomic bludgeon" over half the globe, appeared to be the most attractive of propositions and on mature consideration the only solution to the problem set by the new atomic order of things.

From the military point of view, apart from the fact that it is economic and infinitely quicker to skip the stage of combined warfare, it is obvious that it is more expedient to follow the strategy of Hiroshima and Nagasaki, where a single aircraft produced the same amount of destruction as 210 or 120 similar machines loaded with TNT instead of fissionable material. True, the efficacy of strategic bombing, with the exception of final atomic attacks, has been seriously questioned. Certain writers have declared that the raids on Germany did not achieve their object since there were not only a good number of industries which did not cease production but some of them even increased it, and moreover the Third Reich's will to resistance had not been reduced. What is more, they say, the atomic equivalent of the destructive power poured out over Germany is of the order of 400 to 500 projectiles, a very considerable stock. However, they do not mention that the chemical explosive bombs used by Bomber Command and the Eighth Army Air Force were dropped on their German targets over a period of three or four years, whereas today the same effects could be obtained in a few days, even in a few hours, and that within this brief lapse of time the nation attacked would pass from the abundance of peacetime to the desert of post-war devastation. And for this it would not be necessary to mobilize large air armadas, construct huge numbers of bases or struggle to obtain both quality and quantity in personnel and equipment.

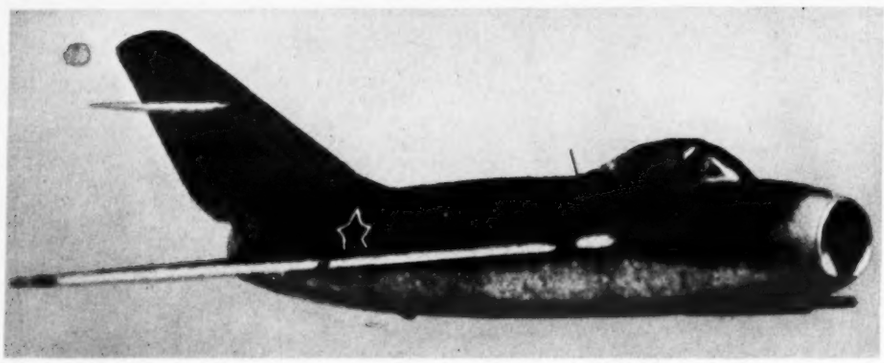
The aircraft with a tradition

The Convair B-36 exemplified these concepts. The machine is well-known. It carries five tons of bombs over more than 10,000 miles, can stay in the air two days, reaches a speed of 420 m.p.h. in the neighbourhood of the target, flies in rarefied air at high altitudes, is armed with fifteen guns, provides a gun platform unequalled by any other attack aircraft, is the equivalent to about thirty "Flying Fortresses" of ten years ago and costs $3,500,000. The Air Force—Navy controversy of two years ago familiarized the public with its picture and with the qualities attributed to it by the Air Force and the faults found in it by the Navy. Invulnerable in the eyes of the Air Force, the B-36 would have succumbed, according to the Navy, to an attack by carrier-based fighters with low wing loading and hence excellent manoeuvrability at altitude. The dispute ended in the triumph of the aircraft over the aircraft carrier and of the Air Force over the Navy. Testifying to the House Military Affairs Committee, General Frederick H. Smith, Jr., chief of the Requirements Section of the Air Force, stated that the B-36 was conceived in 1941 when it looked as if Britain might be beaten and the United States isolated. The need for a long-range bomber, capable of striking from airfields situated on the Continent of America, had been just as obvious since the end of the war. This need had, in fact, been reaffirmed by the tremendous price in human lives and equipment paid for the conquest of advanced bases... The dawn of the atomic era had merely confirmed the importance of an inter-continental bomber. Atomic retaliation would have to be immediate, and there would be no time to wait for air bases to be conquered overseas.

Oft-published map supporting the fable of long-range strategic intervention and air isolationism (1946-1948).

The Boeing B-17 "Flying Fortress" (version G shown) was a medium bomber of World War II. Speed 295 m.p.h., range 1100 miles, bomb load 6000 lbs.

This military isolationism had its roots in the very history of the United States. But the Strategic Air Command was also regarded as constituting a decisive preventative to a general war even more than an instrument of retaliation to an attack launched directly against Federal territory. On the subject of the American atomic bomb monopoly Dr. S. T. Possony wrote in 1949 : "As this country can never be an aggressor, no foreign nation need fear an atomic attack." At the same time economic aid to Europe was beginning to have its effects, and apparent air isolationism was accompanied, in the field of international relations, by a generous policy of support for the peoples ruined by the war. Air, land and naval bases, the positions occupied on the fringe of Eurasia at the end of the last war, had almost all been abandoned, and while the world was slowly regaining its strength, it was believed in Washington that all that was necessary to keep the peace was the threat



The MiG-15, the Russian fighter of which there has been so much talk. A new version has recently been announced. Sonic speeds.

of retaliation with atomic bombs, backed by all the weight of American industrial power. It was also hoped that, when it came to sharing the American atomic monopoly, the Western world, once more on its feet and strengthened by American aid, would be able to achieve a sufficiently stable balance to maintain peace. Hence a policy of maintaining military forces around the old world was no longer necessary. The idea of intervening decisively from a distance, using machines capable of flying half way round the world and operated by a handful of young men was a good deal more attractive than that of holding hundreds of advanced posts requiring immense economic and military resources for their maintenance and defence and a world-wide transport and supply system. Alexander Seversky wrote : "The Japanese error is being lustily preached by the advocates of far-flung bases, scattering and dividing our air forces, stretching our lines of communications in a hundred different directions, leaving us dependent on long overseas supply routes. The enemy would be able to gobble up our scattered strength piecemeal, so that in the final showdown he would face only the remnants of that strength, precisely as we did in Japan. Our continent would be as exposed as were the Nipponese home islands after Japan had dissipated its aerial potential overseas." And the chapter in *Air Power : Key to Survival* from which these lines are taken, is headed : "Overseas bases are untenable."

New strategy required

But less than two years later Hanson Baldwin, military critic of the *New York Times,* remarked that counting the forces immediately available (before Russia had the bomb) and not the potential forces, the U.S. atomic power would have balanced Russia's air and ground power. In the past, he added, U.S. strategy had been based on the principle that if the Red Army attacked Western Europe U.S. long-range bombers would immediately reply by bombing Russian towns, industrial and oil centres, and lines of communications. This concept was now out of date. It had died the day the U.S. had signed the Atlantic Pact, and the Russian atomic explosion had been the last nail in its coffin...

In fact, the strategy of intervention from a distance was militarily condemned from the moment it was officially admitted to be the only policy upon which the U.S. was founding the *status quo* of a changing world, the defence of the West and the security of its national territory.

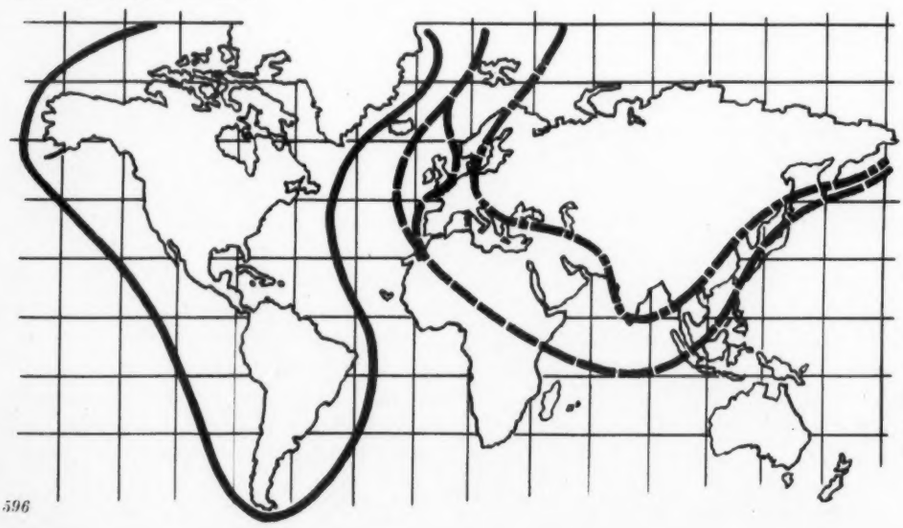
On examination, the concept of a strategy founded on the combination of the long-range aircraft and the atomic bomb is seen to be contestable both as a whole and from the point of view of the real value of each of the elements of the combination.

Considered as a whole, it creates an entirely new situation, the consequences of which do not appear to have been realized quite as clearly by the promoters of the plan as by the nation which might one day have had to experience its effects. The gap between the military potential of one people and that of the strongest of the other nations had never been so great as during the early days of the atomic era. Strategic atomic bombing was perhaps a decisive weapon, but it was also the sole weapon and for this reason it was relatively simple to prepare counter-measures since it was possible to concentrate all efforts on a single article. In other words, while it lightened the military burdens of the U.S., it also simplified both strategy and tactics of an adversary kept in his place by a single weapon, and that weapon well known to him into the bargain.

The mosquito net and the crowbar

By virtue of its omnipotence the atomic bomb introduced a new international *modus vivendi* which was neither peace as the term was understood in pre-atomic times, nor war under atomic conditions. It thus became possible to envisage a whole series of hostile acts, sufficiently rewarding to be attempted but not sufficiently serious to warrant the unleashing of the tremendous force of atomic destruction. Thus "peace" has been stretched to cover a vast series of more or less warlike situations, some of which would at one time have led to all-out conflict but which, since Hiroshima, are none of them individually important enough to justify the weighty intervention of a Strategic Air Command. The scale of these secondary, localized hostilities has also been constantly enlarged. All that was necessary was to proceed step by step, so as to accustom one's adversary to accepting carefully graded *faits accomplis.* Further, this type of retaliation against the atomic monopoly offered a definite advantage to those who understood how to make use of it. In fact it introduced a sort of classification of the nations according to whether an attack on their liberty was likely to set in motion the American atomic machine. Thus, in the face of this type of action, purposely localized and consciously limited, the U.S. found itself back in the conditions of the pre-atomic era but without the appropriate equipment. Rather like an explorer who, laying aside his

Ebb and flow of the positions required by the U.S. Air Force depending on the range of its aircraft—and today depending on the speed-range combination.



The Boeing B-29 "Superfortress" heavy bomber, also dating from World War II. Speed 375 m.p.h., range 4,500 miles, bomb load 20,000 lbs.

mosquito net, decides to use a crowbar to defend himself against insect bites. This means that today, although the combination of atomic bomb and B-36 has perhaps removed the spectre of a general conflict between matched opponents in which it would be the strongest of the conventional military powers, it has nevertheless been found to be completely impotent to deal with a large number of minor aggressions which, taken as a whole, have singularly reinforced the other side's position.

And bit by bit, as the destructive effects of the atomic bomb increased, as the power of the new bombs grew, the extraordinary nature of a weapon which it became more and more difficult to conceive of using became more marked. Finally, the strategic bombing concept was capable of leaving whole nations under the threat of an occupation—even temporary—against which there was nothing to protect them, at any rate directly.

Speed or range, but not both

But it is not only political considerations which show up the disadvantages of air isolationism and its serious consequences. From the technical and tactical points of view it is not yet the hour of the aerial cruiser of supersonic speed and hemispheric range, capable of flying in the stratosphere. It is even possible that such a machine may never have a sufficient technical advantage over the defence put up against it. The time it would take to design and produce such an aircraft would inevitably be long, and the era of the guided missile is approaching. Hence, it may be that tomorrow the ironclad of the air will go the way of yesterday's ship of the line.

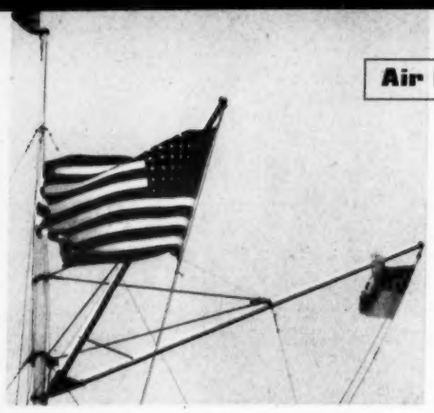
Wisdom dictates that defence be versatile. It is not surprising that the MiG-15 is an excellent interceptor and that other similar machines may one day prove to be even better, even by Western standards of the moment. The reason, of course, is that since 1945 the major preoccupation of the Soviet military staffs and engineers has had to be the defence of Russia against possible bomber raids. No similar fear has so far been shared by the American experts who have concentrated their efforts on the long-range bomber and to a certain extent on the medium fighter, a compromise between the escort fighter and the pure interceptor. There has therefore been a difference in the degree of priority given to the means of short-range defence in the two countries, and Russia has got in first.

The Boeing B-47 "Stratojet" medium swept-wing jet bomber. Speed over 600 m.p.h., range 4000 miles, bomb load 20,000 lbs. A (more powerful) four-jet version, said to reach sonic speeds, has been designed.

But today the engineers who are reaping the fruits of their past efforts have a new worry to share with first the strategists and later the politicians. Everybody knows that the majority of jet-propelled machines are more or less lined up in front of the sonic barrier and that their development has been halted there for some time. Bombers and fighters fly at speeds which are too close together for the latter to maintain the superiority of performance over the former necessary to enable them to accomplish their interceptor mission with the same chance of success as of old. If, in Korea, the MiG-15 has been able to catch up with the B-29 and the F-86 escorts have had to intervene, this is because yesterday's bomber has been pitted against today's interceptor. But it is highly probable that things would have been very different if B-47s had been used instead of B-29s.

Both the Russian concentration on close-range defence and the superiority of the jet bomber suggest that since so much has been sacrificed to endurance in the long-range bomber it is in danger of finding itself in a position of inferiority once it reaches the neighbourhood of its target. True, it may fly at a very great altitude and thus place the interceptor fighter in a difficult position. But the defender has the advantage of being able to leave behind on the ground, in the actual defence zone, all equipment and accessories not essential to firing its guns. Unlike the bomber, which must be independent of ground aids and self-sufficient in all respects, it is relieved of all tasks which can be performed on the ground.

Finally, since it has not yet been possible to reconcile speed and range or, to use a cognate image, to pierce both the wall of sound and the wall of distance, military staffs and engineers find themselves in the following dilemma : should aircraft be based on national territory, with the consequent saving of the expense of advanced bases, and approach their target at a speed which would normally lay them open to attack by enemy forces, or should, on the contrary, range be sacrificed and aircraft operate from close quarters under conditions approaching those of the enemy's air defences ? It looks as if, in time, the second alternative will win and that speed will come out on top. This is why, now that the long-range strategic weapon has filled the gap between demobilization and rearmament, the plan is to bolster up its efficiency—temporarily on the wane—by a close-range force operating at near-sonic speeds. This, then, gives the bases round Europe and Asia the same importance as the aerodromes which invested the "fortress of Europe" ten years ago.



Air Bases

"Sad Sacks" at Home

Life at a U.S. Bomber Base in Britain

SAD Headquarters

It started incongruously enough: the porter handed us a message when we got back to the hotel—"Ring Major James R. Patterson tomorrow morning after nine o'clock, Waterloo 4300." We had been trying to get into touch with USAF headquarters in Britain to obtain permission to visit one of the American "Superfortress" bases in England, and this was the first result of our enquiries.

Next morning we did as told, although we had been wondering how USAF headquarters, which is located at South Ruislip, some miles west of London, came to have a Waterloo telephone number. A feminine voice without a trace of a transatlantic accent answered: "Waterloo 4300. Good morning." "May we speak to Major Patterson?" "I don't think we have a Major Patterson here, but I'll check." "Isn't that United States Air Force headquarters at South Ruislip?" "United States Air . . . NO, Sir, this is Lambeth Palace, London Residence of the Archbishop of Canterbury."

We had told the Editor we were taking a day off to visit an American air base and therefore couldn't very well come back with a story on the private life of the Archbishop. More telephone calls ensued, and we finally succeeded in contacting Major Patterson at Waxlow 4300. He informed us the visit could be arranged, perhaps we would like to come out to Ruislip to fix the details . . . ?

Douglas C-124 transports provide some of the logistic support for USAF bombers in Britain.

You could tell "Little America," South Ruislip, Middlesex, a mile away: dozens of 1950 and 1951 American automobiles lined up in a car park in front of a vast block of low, yellow brick buildings, a modern factory converted into headquarters offices, well-fed air police in their new, blue uniforms standing guard at the gate.

Major General John Paul McConnell, Commanding General, 7th Air Division, Strategic Air Command.

Major James R. Patterson, a reserve officer who had been flying the "Hump" into China in Curtiss C-46 "Commandos" during the war, received us amiably. He told us that in private life he had been a reporter on the Kansas City "Star" and had been recalled to the Service about three months ago. He lives in a rented house in Ruislip with his wife and small daughter, who had had to take to the hills to escape the recent flood disaster in Kansas City and who had just arrived in England.

We explained that we should like to see a bomber base, or alternatively one of the new North American F-86 "Sabre" interceptor fighter bases. It would have to be a bomber base, he said. This part of the building was headquarters of the *Seventh Air Division, Strategic Air Command* (SAD, SAC), and the Division only had Republic F-84 "Thunderjet" escort fighters, in addition to the bombers, but the F-84s had just arrived and hadn't settled down yet. The "Sabre" interceptors belonged to the USAF Third Air Force. (Incidentally, the ground personnel have been quick to use the abbreviation for the Division to christen themselves the "SAD SACKs"—purely on account of the weather, he assured us.) In reply to our enquiring look he explained the set-up of the American air forces in Britain.

The Seventh Air Division was formed on May 1st, 1951, at the time when the former Third Air Division (cf. "Interavia Review" for May, 1950) under Major General Leon W. Johnson was raised to the status of an Air Force (the Third). SAD reports directly to Strategic Air Command headed by Lieutenant General Curtis E. LeMay, with headquarters at Offutt Air Force Base, Omaha, Nebraska. In the reorganization of May, 1951, SAD took over many functions formerly performed by the Third Air Division, particularly in the operational control of Strategic Air Command units assigned for training to the United Kingdom on a rotational basis. The Third Air Force (which has its headquarters in the same building at South Ruislip) continues to furnish logistic support to SAD by the maintenance of supply depôts and other services.

Yes, we said, we had got that. SAD is commanded by Major General John P. McConnell, the Major continued. Wasn't he in the India-Burma-China theatre during the war? we ventured. Right, said Patterson, and gave us a few pertinent details of the General's career. He was born in Arkansas in 1908, joined West Point Military Academy in 1928 and was commissioned in the Field Artillery in the Regular Army in 1932. A month later he joined the Air Corps flying schools and graduated as a fighter pilot. After America's entry into the war at the end of 1941, he held various appointments in India and Burma, notably that of Deputy Commander of the integrated USAAF-RAF Third Tactical Air Force in the Burma area. He returned to the USA after the war and in July 1950 was sent to England as Deputy Commander of the Third Air Division. He assumed command of the Seventh Air Division on May 24th, 1951.

Would we like to meet the General? If that was not too much trouble, we said, and five minutes later we were shaking hands with the boss of the U.S. Strategic air units in Europe—a tall, wiry man speaking in clipped, military tones but with a gentle smile around his eyes. He was sorry not to be able to give us much time, he said, but he was getting ready for a quick trip to Washington.

SAD Rôle

The organization of the Seventh was still in the process of being built up, he told us. To

Colonel Francis W. Nye, Director of Operations, 22nd Bomb Wing.

explain the mission of the Seventh Air Division it was necessary to understand something of the SAC Rotational Plan under which units of the Command are sent to England for what is normally a 90-day tour of temporary duty. These units include three medium bombardment wings of Boeing B-29 and B-50 "Superfortresses," fighter escort groups of Republic F-84 "Thunderjets," tanker units of Boeing KB-29s which are used for air-to-air fuelling, and reconnaissance squadrons. The bombardment, refuelling and reconnaissance units operate from bases at Lakenheath, Mildenhall, Wyton, Bassingbourne and Sculthorpe in East Anglia, while the fighter escort units use the famous World War II base at Manston, Kent. Some of these bases are in the process of expansion, and additional ones are under construction at Brize Norton, Upper Heyford, Fairford and Greenham Common in the Oxford area. While over here, bomber and escort fighter crews undergo intensive training under conditions which resemble combat conditions as closely as possible. Several important advantages are gained under the Rotational Plan : first, invaluable experience is obtained in meeting the operational, logistic and administrative problems encountered in the transfer of a group or squadron to an overseas base ; second, there is the value of joint training exercises with the RAF and other NATO air forces ; and third, the units learn about such factors as weather in this part of the world, terrain features and navigational aids. But, added General McConnell, you will find out during your visit how all this works out in practice.

Two telephones began to buzz on the General's desk, so we said we wouldn't hold him up any longer and wished him a good trip.

We took the opportunity to look around the headquarters buildings for a while. Dozens of offices, some of them marked "Keep Out" and "Forget what you said, heard and saw in here," employ about 700 SAD and Third Air Force Staff personnel. One of the most fascinating places is the Post Exchange, or PX, which sells every conceivable kind of food and merchandise, from uniforms to canned pears, radio-gramophones, refrigerators and bicycles —all priced in dollars and free from the British 66-percent purchase tax. Refrigerators cost anything up to $200, washing machines are from $136 up, radio-gramophones $120, etc. Next to the PX "Alexandre," the tailor, has opened a made-to-measure men's shop, for officers and men change into civilian clothes when they step out at night.

Our visit was suitably concluded in the noisy coffee shop of the PX, where we had a cup of typically American coffee and some doughnuts. The background noise was provided by the inevitable juke-box.

The 22nd Bomb Wing

Two days later we were driving the 80-odd miles from London to the air bases at Mildenhall and Lakenheath, in Suffolk. The weather

Entrance to Lakenheath air base. At left, Major James R. Patterson, Public Information Officer, SAD, SAC.

seemed promising but unusually autumnal for the beginning of September, and by the time we arrived at Mildenhall it was raining in torrents.

On our way to the station building inside the base perimeter we passed through a vast area where work was in progress "à l'américaine." Bulldozers, excavators, earth trucks spotted the field. "They're extending the runways," explained Major Patterson, "the longest one from 5,850 feet to 9,000 feet, the other two to something less than that."

Mildenhall is now a combined RAF and USAF base and is the headquarters of the 22nd Bomb Wing of the Seventh Air Division, Strategic Air Command, which is composed of three squadrons of B-29s. The Wing arrived there on its 90-day rotation a week before our visit and will leave again at the beginning of December. When work at Mildenhall is completed, one squadron will be stationed there, another at Lakenheath and one at Sculthorpe. At present, one is at Lakenheath, one at Sculthorpe and one at Wyton.

What struck us most both at Mildenhall and Lakenheath was the difference in atmosphere from Ruislip headquarters. There an air of quiet and "plenty of time" provided the dominant note, here they were getting on with

General McConnell confers with his boss, Lt. General Curtis E. LeMay, at Mildenhall air base.

the day-to-day work of operating an air base. Another feature was the complete absence of the proverbial nonchalance of American officers, NCOs and men and of the equally famous abundance of equipment. Business is conducted in "no-nonsense" military style, practically under field conditions, although we did notice a larger number of staff personnel than one is accustomed to in the RAF and other European Services.

We were introduced to 33-year-old Colonel Francis W. Nye, of Barton, Vermont, Director of Operations to the 22nd Bomb Wing, a very crisp and friendly young man, who quite obviously took pride in his work and pleasure in talking about it—within the limits of security regulations. The Wing was activated at Mitchell Field, New York, in 1940 and fought from Australia to Okinawa in 3 ½ years. It was dissolved at the end of 1945 but reactivated with B-29 "Superfortresses" at Smokey Hill Air Force Base, Silana, Kansas, a few months later, in June 1946, and moved to March Air Force Base, Riverside, California (formerly a fighter base), in May 1949. In November 1948 the Wing left for the United Kingdom for its first post-war three-month overseas training mission ; a second mission followed in November, 1949. In July, 1950, the Wing became one of the first units of SAC to be ordered for combat duty to Korea. Nine days after receipt of orders at March Field, the Wing was fully operational in the Far East and participated in bombing missions against the North Korean Communists. It spent four months in Korea and then returned to March Field.

Within three days after leaving March Field early in September, 1951, the Wing was operational in England. It had made one stop at Goose Bay, Labrador, and then hopped across the Atlantic. Out of the thirty aircraft, only one developed engine trouble and arrived two days later. Total flying time was 23 hours. The wing could have started training operations the next day—all equipment had been brought along, staff papers and documents neatly packed in special "fly-away kits."

"That shows the mobility of air power," says Colonel Nye. "And we are making a maximum effort to benefit by this training tour. One of the advantages is that we are working under field conditions—away from our home base and families. We are flying a practice mission every three days, and some of these last ten hours or more. Some of our navigational training flights extend to Africa and the Gulf of Aden. Other training flights include live bombing missions and air-to-air fuelling flights. We have an interception exercise at least three or four times a tour, either in cooperation with the RAF or the U.S. Third Air Force. All our air gunners have camera guns to enable us to evaluate their proficiency...

"Since the rotational plan of SAC was put into effect in July 1948, all medium bomber units of the USAF have had at least one tour in England. Jet bombers? Sure, the Boeing B-47 "Stratojets" will also take part in the plan as

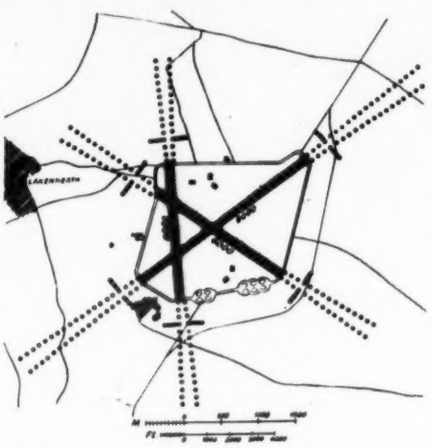
Two briefing systems : *left*, the conventional array of maps ; *right*, the sliding maps designed by Colonel Lamm. The Colonel is at the right.

soon as squadrons have been formed. No Convair B-36s, on the other hand : they belong to another strategic concept, as you know, and are expected to take off from the USA, fly to their targets, and return to their home bases."

USAF—RAF Cooperation

"How does your cooperation with the Royal Air Force work out ?" we asked. "Absolutely smoothly," said the Colonel, "and I really mean it." If we want something we just ask the liaison officers for it, and we get it—anything excepting things involving top level decisions. These are referred to Seventh Air Division Hq., who refer them to the Third Air Force, who take up the matter with the Air Ministry.

"For instance, we use the bombing and gunnery ranges of the RAF free of charge ; we practise at Heligoland as much as they. They also provide support facilities, such as gasoline. We buy the gas off them, of course. We get our bases rent-free, but we pay a nominal charge for utilities, such as heat and light, on an annual basis. The charge is about £30 per man per year, I think. Any work carried out as a permanent improvement of the military value of the base, such as the lengthening of the runway out there, is shared on a 50 : 50 basis. We provide our own ammunition and bombs—the latter chiefly from stocks left over here from the last war. Ultimately all food, soap and cigarettes for U.S. airmen will be imported



Lakenheath air base diagram.

dutyfree, but at the moment we're still using some of the RAF's messing arrangements . . ."

"No," the Colonel replied to our question, "we don't bring our own base personnel for our rotational tours. Each base has an Air Base Group of 500 to 700 "housekeeping" personnel. They are stationed here for three-year tours of duty and provide an element of stability, as at USAF bases at home. They also ensure continuity of supply and transportation as well as the RAF liaison for the SAC units which alternately use the fields in the United Kingdom. Air base personnel get 30 days' annual leave, in addition to short leaves . . ."

And, to another question : "Well, I guess about 60 percent of combat crews are reserve—we known them as "involuntary recalls"; 30 percent are reserves on active duty, 10 percent are regular Air Force personnel."

We said good-bye and moved over to the Officers' Club for lunch. The menu consisted of vegetable soup and crackers ; braised beef ; buttered noodles ; buttered cabbage ; buttered asparagus ; tossed green salad ; cherry pie ; coffee. Price of the menu is 45 cents (U.S.). Americans are not allowed to pay in English money : they use "scrip" a special military currency accepted at all U.S. military posts overseas. Lunch, incidentally, was excellent and above average British austerity standards. It was prepared by British personnel, too.

Cooking arrangements at SAD air bases are still somewhat confused and occasionally give rise to wisecracks. British personnel are kidded because of the relative primitiveness of their cooking, Americans are teased because of their weird tastes. At Manston, for instance, the food is American but the cooks are British ; at Mildenhall both food and cooks are British, while American cooks prepare American food at Lakenheath. Needless to say, the Americans at Lakenheath are envied by the others.

The Operating End of the Line

After lunch we drove to Lakenheath air force base, only about eight miles away. It was raining hard, and we had visions of having to tramp around the field in pouring rain. In some parts of the base the drainage system had gone haywire and water was more than a foot deep on some of the base streets, but none was on the runways. We learned later that a terrific thunderstorm had ravaged London in the morning and had provoked floods in the South of England. So we thought perhaps we had been lucky to travel northeast, even if we did get into the tail end of the storm.

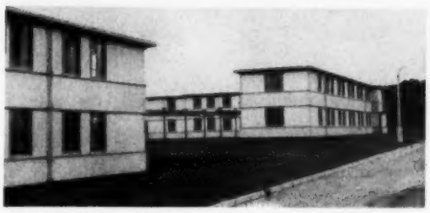
The first sight that met us at Lakenheath was entirely unmilitary : a little boy, the son of one of the men based at the field, was riding the tire of a bomber nosewheel suspended from a branch of an oak. This peaceful impression was quickly dispelled as soon as we got to the operations building of the base. Here again an

Quarters of air base personnel on three-year tour of duty. The men live with their families.

atmosphere of intense activity pervaded the rooms and corridors. There was a notable difference from Mildenhall, however : the latter was Wing headquarters, with an odd aircraft standing on the runways not under expansion. Lakenheath, on the other hand, was the home of the 19th Bomb Squadron, and via Division headquarters at Ruislip and Wing headquarters we had at last arrived at the operational end of the set-up.

We met Lt. Colonel L.J. Lamm, of Vici, Oklahoma, a young (about 30) veteran of 30 combat missions in Korea and 40 World War II missions in the Pacific, who now commands the 19th. During the war the 19th had made itself a name for toughness throughout the Pacific. By January, 1943, for example, heavy fighting had severely depleted the strength of the wing, which then was equipped with Martin B-26 "Marauder" light bombers. It was found that only enough aircraft remained to equip one squadron—and the crews of the 19th insisted that these, "held together by wire, string and guts," be assigned to their outfit.

Lt. Colonel Lamm took us to the briefing room to show us the ingenious briefing display he and a few helpers had rigged up within 48 hours of their arrival. It consists of several sliding panels, split down the middle, enabling each step in the briefing to be conducted quickly and graphically. The top panel shows a map of the whole operating theatre, from England to France and Central Europe, including the traffic control zones. The route of the practice mission is determined by means of this map, the panel is then pushed aside, and under it appears a larger-scale map of the area surrounding the practice target—on the last mission the South-East of England—by which the approach routes to the targets are fixed. The next panel is a map of the target area itself, which in this case was Southall, just west of London. Again this map is pushed aside to reveal the fourth and last display, a weather chart. All panels are coated with a resistant varnish, enabling routes and targets to be marked and washed off in a minute.



Six blocks are provided for personnel on temporary duty (TDY) under the Rotational Plan, two for officers and four for airmen.

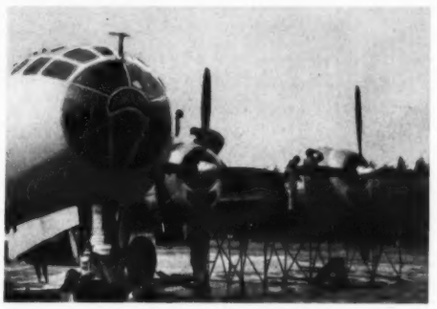
Entrance to one of the blocks.

At the left of the briefing panel is the mission schedule giving the names of the crews taking part in the flight ; at the right is the communications schedule, indicating radio channels and frequencies and the use to which they are to be put. At the far left is a diagram of the proposed flight formation.

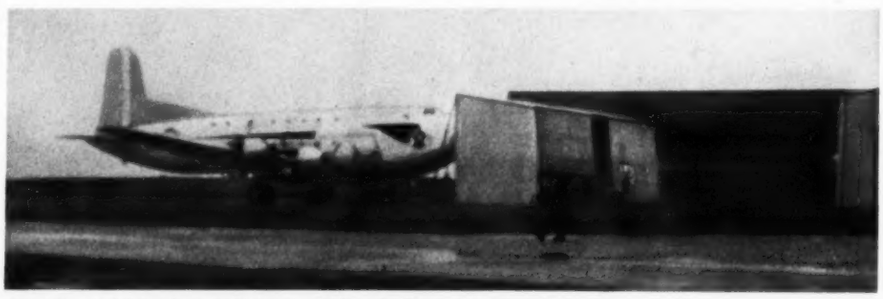
"On our last but one mission," Colonel Lamm tells us, "we did 5½ hours of high-altitude formation flying at 25,000 feet, from Lakenheath to Cuxhaven and Heligoland."

Tough Training

"A typical training mission ? The last one took us over 2980 miles ; we flew in formation from Lakenheath to Reading, then down to the bombing range on the sands near Brest, to La Rochelle and Rochefort on the West Coast of France. There we climbed to 25,000 feet and flew in formation across France to Mannheim and Munich, then north (at one time only 36 miles from the Iron Curtain, the Colonel smiled) to Cuxhaven and Heligoland and Great Yarmouth. At Great Yarmouth we dispersed, some of us going to Scotland, some to Bristol, then south to Cherbourg, north to Plymouth and from there right into the target area at Southall. And then home to Lakenheath. We call these flights Operational Readiness Test



Daily inspection, light maintenance and servicing is carried out in the open.



A mobile "dock" has been built for the C-124s of Military Air Transport Service.

The crew we interviewed. *Left to right :* Captain Forrest E. Clark, of Long Beach, Calif., pilot; 1st Lieut. Marion E. Grimwood, Pasadena, Cal., co-pilot ; 1st Lieut. Robert J. Morrison, Bronx, N. Y., navigator ; 2nd Lieut. Forrest S. Zeno, Los Angeles, Cal., bombardier ; 1st Lieut. Walter F. Pfeiffer, Little Rock, Ark., radar observer ; Master Sgt. Arnold W. Womack, Chattanooga, Tenn., flight engineer ; Tech. Sgt. Jose N. Rodriguez, San Bernardino, Calif., radar observer ; Tech. Sgt. William C. Hubbell, Cleveland, O., central fire control gunner ; Tech. Sgt. Manuel Espinoza, Van Nuys, Cal., left scanner; Staff Sgt. Billy Simmons, Okamulgee, Okla., right scanner; Sgt. Robert Ford, Los Angeles, tail gunner.

B-29s of the 19th Bomb squadron at their dispersal at Lakenheath. The forest in the background belongs to the Crown.

Crew members discuss a point pending the arrival of the pilot and co-pilot.

(ORT) missions, and do the boys have to work? The bombardier gets practice during the target runs, the gunners during the frequent 'enemy' interceptions. Anyway, they sleep well at night."

Would we like to talk to one of the crews? the Colonel asked. There was one down near its aircraft, the last one of the line. We drove along miles of taxi strips and runways, past dispersed "Superfortresses," one or two Douglas C-124 giant cargo aircraft and four "Thunderjets" that were just getting ready to fly back to their base at Manston. Each aircraft was guarded by an airman armed with a rifle, while maintenance personnel were getting the machines ready for the next flight. The USAF has recently introduced a change in its maintenance practice. Formerly a complete maintenance crew under a crew chief was assigned to each aircraft. Now, as a result of the highly specialized equipment of the machines and probably also due to a shortage of skilled men, technicians move from one aircraft to the next to carry out their specialized maintenance work.

There was the B-29 crew we were meeting. At our request they lined up before the aircraft so we could take a photograph. "Like it over here?" we asked one of them, Master Sergeant Arnold W. Womack, of Chattanooga, Tenn. "Swell," he shivered in the rainy wind.

What struck us about these men was the fact that none of them were very young—several must have been well over thirty. Perhaps that was because most of them are World War II veterans, partly also because the handling of the big bombers takes seasoned personnel. The eleven-man crew of a B-29 or B-50 consists of the following: pilot (the skipper), co-pilot, navigator, flight engineer, bombardier, central fire control gunner, two radar observers, left and right scanner, and tail gunner. The functions of most of them are evident from their designations, but some of the latter need amplification: (1) the *bombardier* does the sighting and bombing, but he also acts as a gunner, repairs malfunctioning equipment in flight and writes a report of observations during flight; (2) the *radar observers* determine the location of the aircraft in relation to the target, obtain navigation information and transmit it to pilot, navigator and bombardier; (3) *the central fire control (CFC) gunner* directs the firing of any or all defensive guns on enemy aircraft; the *scanners* prepare all weapons for air-to-air gunnery, watch out for friendly or enemy aircraft to alert for action or prevent air collisions, and keep the flight engineer and pilot informed of engine fires or malfunctioning.

We left them then, still shivering in their thin flying overalls. They had just come from sunny California, we remembered, and even the bombers—heated, of course—must be more comfortable at high levels than the rain-laden wind blowing across the East Anglian plain.

"Private Life" at the Air Base

Back at the habitable part of the base, we took the opportunity to find out how officers and men live. Crews of the squadrons in training are quartered at solid prefab-type steel-frame buildings put up by the RAF. There are six fairly large, identical blocks of these, two for officers and four for airmen. Each block contains 84 single rooms and four larger rooms for squadron commanders and senior officers. Quarters are well-heated (Americans get an extra fuel allowance), and the rooms are furnished comfortably enough—a bed, wardrobe, dresser-cum-writing desk combination and enough storage space to take the 65-to-100-lb. luggage allowed each crew member for the trip. There is a pleasant officers' club with lounges, mess hall and games rooms, with billiards, table-tennis and darts. There is also an NCO's club, as well as the usual canteen, complete with juke box, for the airmen.

An American staff sergeant from the 22nd Bombardment Wing learns the finer points of a snooker game from two RAF sergeants.

Quarters for personnel of the air base groups on three-year tours of duty are more elaborate and consist chiefly of pleasant, small brick houses for the men and their families. A shortage of such accommodation still persists and some of the base officers live in rented rooms and houses scattered for miles around the base.

For the men stationed abroad for longer periods the USAF and various auxiliary organizations provide a vast range of educational and recreational activities. Off-duty classes to regular (U.S.) university standards are offered in history, psychology, foreign languages, logistics and other subjects, and students can graduate as Bachelors of Science and Bachelors of Military Science. So far 50 to 60 have enrolled for the classes at Lakenheath, but this is expected to rise to about 150 when the base reaches its full complement of 700 personnel. Air Force "Special Services" is also running an "Information and Education" programme of lectures of topical interest, notably to familiarize USAF personnel with their surroundings; in the first half of September two of the lectures were entitled: "British Economics" and "British Schools." Furthermore, personnel can enrol for an array of correspondence courses ranging from "Aircraft Engineering" to "How to Run a Newspaper." Finally, "Special Services" is authorized to hire local lecturers on typical subjects.

Sports activities at Mildenhall and Lakenheath comprise basketball, football, softball and baseball leagues, track teams, soccer teams and square dancing clubs. Teams from the various bases compete with teams from others and with British Service teams. The story is told that a USAF cricket team trained very carefully and in secret—and beat a RAF team at its national sport . . . and that a RAF baseball team then trained very carefully and in secret—and beat the USAF team at its national sport . . .

These extra-curricular activities are rounded off by such typically American events as dances, card parties, Bingo, "music appreciation hours," quiz programmes, dancing classes, group singing, swimming parties, "scenic tours," "glee clubs"—briefly, by everything fertile minds can invent to keep the personnel of the Seventh Air Division from living up to their self-applied nickname, "Sad Sacks."

They Take it Seriously . . .

As we left base we passed a group of airmen —they are no longer called "GIs"—laughing and joking on their way back to quarters. A little further on we came across a group of "bad boys," a working party of minor offenders followed by two stalwarts of the Air Police, rifle at the ready. "We're working on a combat-readiness basis," commented Major Patterson, "and can't allow too much nonsense."

On the way back to London we mulled over our impressions. These amount to the realization that the enthusiastic young men of the USAF in Europe are in deadly earnest, training hard, building up their efficiency against the day they hope will never come.

Airborne Refuelling Bases

BY CAPTAIN NORMAN MACMILLAN, M.C., A.F.C., A.F.R.AE.S.

Concurrent advances in aviation should compel military air staffs to work long hours in an effort to evolve tactics which will derive most profit from this technical progress. Air tactics of World War II are already largely out of date and need reconsideration, only six years after the end of the greatest war in history. This new situation has been created by the swift development of jet aircraft, which have introduced faster speeds at the expense of a vastly greater consumption of fuel. These are weapons changes.

In this connection I wish to quote from Admiral A.T. Mahan's outstanding study of strategy and tactics, "*The Influence of Sea Power Upon History*" ". . . Changes of tactics have taken place *after* changes in weapons, which necessarily is the case, but the interval between such changes has been unduly long. This doubtless arises from the fact that an improvement of weapons is due to the energy of one or two men, while changes in tactics have to overcome the inertia of a conservative class ; but it is a great evil. It can be remedied only by a candid recognition of each change, by careful study of the powers and limitations of the new ship or weapon, and by a consequent adaptation of the method of using it to the qualities it possesses, which will constitute its tactics. History shows that it is vain to hope that military men generally will be at the pains to do this, but that the one who does will go into battle with a great advantage . . ."

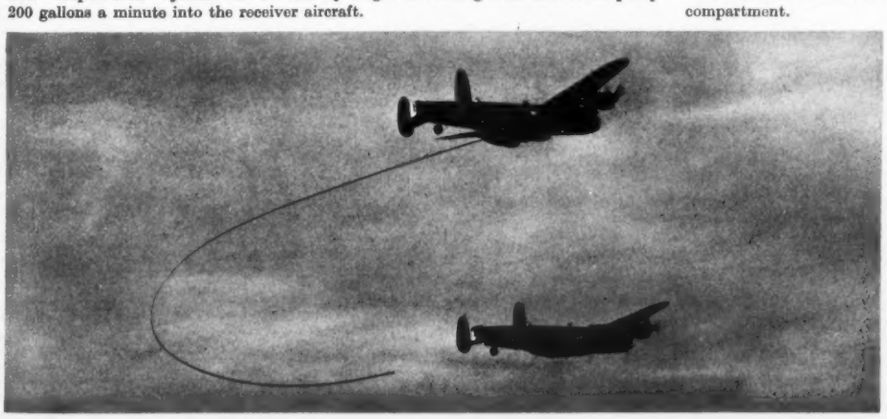
Mahan is concerned mainly with ships and naval warfare, but he deals with basic principles of universal application. And there is a great similarity between sea and air warfare. Both are highly mobile. Both require fixed and numerous bases. Both involve strategic planning and tactical handling. Range and duration, fire power, and quantity of embarked warlike stores are common problems, as are speed, manoeuvrability, crew training, the personal courage and tactical skill of the captain in association with his appreciation of a situation. So we may assume, with Mahan, that a change in the construction of aircraft will result in changes both in the manner of handling them individually, and in the disposition and handling of air fleets.

Already this has begun to happen. New drill has had to be introduced to bring jet fighters into airfields. Their duration is so short that there is little available time to stand-off before alighting. But many things have not yet received attention. The jet engine is lighter than the piston engine relative to power output. But its fuel consumption is so much greater that the reduced engine weight has brought no reduction in all-up weight. The "Hurricanes" and "Spitfires" that fought in the Battle of Britain in 1940 weighed about 6,000 to 7,000 lb. The "Mustangs" and "Tempests" that ended that war in 1945 weighed about 10,000 to 12,000 lb. *Jet fighters today may weigh between 20,000 and 30,000 lb.* Structure weight, fuel load, armament load, equipment load have all gone up as power has increased. Speed has increased. But absolute manoeuvrability has decreased, although relative manoeuvrability between jet bombers and jet fighters may remain.

Airstrips of better construction and of greater length are required for these modern fighters and ground combat planes. It must be considered whether it is wise to site such airstrips close to the ground fighting zone, because of the danger of being overrun by mobile armoured columns. (In some combat zones the nature of the terrain may preclude the forward siting of such airstrips altogether.) Thus the nature of the modern jet fighter demands that its operational bases may have to be sited farther to the rear of the ground combat zone than has hitherto been the case for fighter aircraft, with the result that flight duration over the combat zone may be reduced. Experience in Algeria-Tunisia, at Salerno, Anzio, and in Korea has outlined the handicaps to strategic planning and tactical operation when fighter aircraft have insufficient battle duration.

Because of its augmented speed the jet fighter has a greater range than the earlier piston-engined fighter of the same class. It is therefore possible to station the jet fighter farther back from the ground combat zone in order to secure the advantage of better airstrips, and yet gain utilization over the battle area equal to that of the former piston-engined fighters. But is this enough ? I think not. Such brief duration over the combat zone—perhaps 12 to 15 minutes—demands too heavy a reinforcement rate of patrols (five to six an hour to provide continuous cover) which in turn requires a vast ground organization to build and service airstrips and their aircraft. If this defect is overcome by increasing external

The "looped hose" system was devised by Flight Refuelling Ltd. and could pump 200 gallons a minute into the receiver aircraft.



The "probe-and-drogue" was designed by the same company and is being tested by both the USAF and the RAF. It transfers 600 gallons per minute. Picture shows a USAF B-29 about to contact a trailed drogue with the probe protruding above the pilots' compartment.

tankage, speed and manoeuvre are sacrificed, while if it is overcome by increasing internal tankage, weight, size and fuel consumption go up, and speed and manoeuvre go down.

The bomber and reconnaissance problem is not the same as that of the fighter. The crucial factor here is range, and, in the bomber and anti-submarine aircraft, the load of bombs, mines, and/or depth charges, plus weight and bulges of defensive armament and electronic equipment. The forward airfield presents even greater problems than in the case of the fighter, for with bomber aircraft the weight to be supported by the runway may be five or more times that of the heaviest fighter. It needs no mathematical presentation of the facts to understand that any means of augmenting fuel without adding to all-up weight and size of the aircraft is of the utmost value provided it is not obtained by diminishing the offensive and defensive weapon load.

The conditions facing the air strategist today are more onerous than those that faced him in World War II. Two great continental land masses, Asia and America, are major base establishments and are therefore subjects for strategic air attack. The radial ranges involved in such attacks are at least three times greater than those which had to be considered for World War II. If such radial ranges are to be within the compass of aircraft carrying self-contained loads of fuel and defensive and offensive weapons, the type of aircraft required will be very large, very costly, and slow in construction. But if an advanced base can be used, where a portion of the fuel to fulfil a given operation may be obtained, the onerous conditions of cost, absorption of manpower and materials, and slow rate of output can be overcome, by using other means of transport to carry some of the fuel to the advanced base.

In making use of an advanced base, it must be remembered that every landing is attended with an element of risk which is greater than the element of risk in continued flight. Moreover, the tyre life of modern aircraft is limited to a small number of landings, and so every landing increases the maintenance problem. If, therefore, the range and load conditions can be effectively fulfilled without landing time is saved, and the disadvantage of intermediate alighting at an advanced base can be avoided. There is less strain on the aircrews. The starting base is farther from enemy attack and therefore safer, and there is no risk of the aircraft being damaged or destroyed at the advanced base when landing or starting or while grounded. If the full strategical range necessary to be able to attack any point of enemy territory is available to the strategic commander-in-chief, a degree of mobility is placed in his hands, which, if exercised with wisdom and backed by a sufficient force of aircraft, will compel the enemy to deflect a large part of his overall war effort to the defensive. To restrict the enemy's choice of action by forcing him on to the defensive is a cardinal principle of war. The importance of strategic air warfare lies in its capacity to further this principle; its value stands in more or less direct relation to the ability of the aircraft used to attack any part of enemy territory with a sufficiently destructive force.

It seems clear, if another world war should overwhelm mankind, that the initiative will pass into the hands of the contestant who is able to bring and continue to bear upon any and every desired part of the opponent territory, a *weight of air attack sufficient to throw that opponent on to a full-scale defensive*. Enough experience of air warfare has been gained to show that limited means and limited range will not have a sufficiently potent effect, and that an opponent will not then be compelled to make such a diversion of effort as will incommode his own offensive strategy. Therefore, in the face of the existing intercontinental strategic situation, increasing attention is now being paid by the American and British military air authorities to the *extension of range of bombers and of duration of fighters by refuelling in flight*.

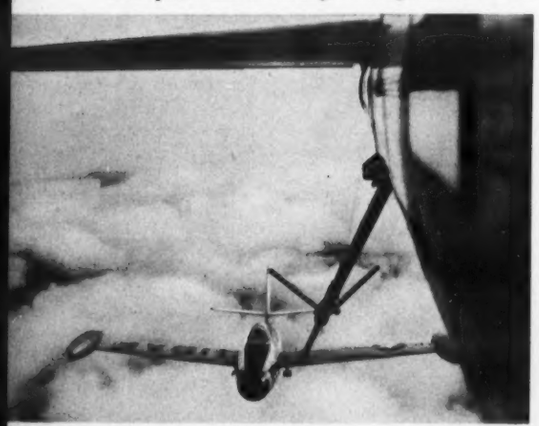
The "probe-and-drogue" system is being tried out with numerous aircraft types, here with a Gloster "Meteor" fighter.

Airborne refuelling offers the fighter the use of adequate airstrips in suitable country, far enough to the rear to make possible the use of radar for defence of the airstrip and aircraft grounded thereon. Yet the speed of jet fighters enables ground forces to receive fighter and ground-attack support quickly, even when the airstrip is sited well back from the combat zone. There is less danger of the airstrip being overrun by enemy tanks, and it can be fully evacuated in emergency. And with these positive advantages the air-refuelled fighter and ground-attack plane can still maintain adequate duration over the ground forces, thus raising aircraft utilization to a higher efficiency. If necessary, the fighter can be refuelled several times in the course of one patrol, and remain airborne for several hours if not compelled by expenditure of ammunition or other causes to return to the airstrip. This was demonstrated by the Transatlantic air-refuelled flight made by Colonel David C. Shilling of the USAF in a "Thunderjet" F-84E from Manston in Kent, England, to Limestone in Maine, USA, on September 22nd 1950 in 10 hours 2 minutes, when he refuelled off Prestwick (Scotland), Keflavik (Iceland), and between Greenland and Cape Harrison (Labrador).

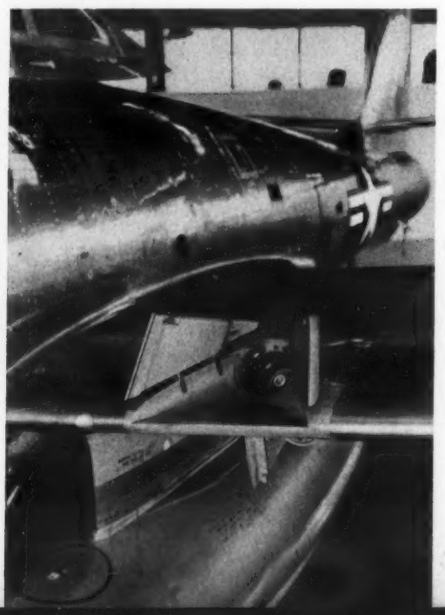
One tanker of the B-29 or "Lincoln" types could maintain a squadron of fighters in fuel. Two tankers would speed up the operation and increase duration still further. If each tanker refuelled three fighters simultaneously, a squadron of 12 fighters could be refuelled in ten minutes or less.

This is a matter which must be worked out operationally by the military authorities who wish to employ these means to increase operational efficiency. Certain tactical formations and methods of refuelling will give maximum military efficiency over a given combat zone. It would appear that the most efficient method would be that which lost least time between a fighter squadron splitting formation in order to refuel and the rejoining of its formation again. Four tankers, each refuelling three aircraft, could complete the operation in about five minutes. Fighters should then operate in groups of four units. One unit of each group would fall back in rotation to refuel, thus maintaining three units in action throughout the duration of the extended patrol. With four

The big rival of the "probe-and-drogue" is the "flying boom" system developed by Boeing Airplane Co. The "boom operator" of the tanker stabs the metal refuelling tube into a refuelling coupling on the receiver aircraft. Picture shows a Republic F-84G "Thunderjet," especially developed for mid-air fuelling, receiving fuel from a B-29.



The refuelling receptacle on the wing of the Republic F-84G fighter.



A Boeing C-97 "Stratofreighter" tanker refuels a B-50 bomber by means of the "flying boom."

The "flying boom": the "ruddevators" on the telescoping tube enable the boom operator to control the tube aerodynamically and connect it with the receptacle on the receiver aircraft flying up behind.

suitable tankers to a group having four squadrons as units the total duration of flight could be doubled or even trebled, and duration over the combat zone multiplied many times. Protection for the tankers would be provided by the fighters themselves, supplemented when required by ground gun and rocket support, for the refuelling would be carried out usually between 10,000 and 30,000 feet. Radar IFF in fighters and tankers would ensure their safety from friendly ground weapons in bad visibility. Refuelling operationally in flight should not involve fighter aircraft or tankers in abnormal risk, and losses during refuelling would probably be slight compared with losses often suffered from enemy fighter action during refuelling on the ground.

The bomber case is somewhat different. The extension of range required may be much greater, and the penetration of enemy territory much deeper than in the case of fighters. Careful consideration must be given to devise the best way to obtain maximum results in any postulated operation. To obtain maximum increase in range the refuelling operation may have to take place over enemy territory. In this case it should be planned to occur over territory which is not strongly defended by ground weapons, and photographic reconnaissance will be required beforehand to ensure this. Fighter escort will be required at the refuelling point, and with the use of flight refuelled fighters, there should be no difficulty in providing this. It appears, however, that here the USAF system of integrating fighters with bombers in operational commands is better than separating fighters and bombers into functional commands as in the RAF, and that bomber commands in future ought to possess a fighter-refuelling-escort group in order to simplify planning at bomber operational headquarters.

The use of flight refuelling by bombers is subject to a number of variations. If necessary, the bomber can take off with reduced fuel in order to lift a greater weight of bombs, and then refuel shortly after take-off. Then it can additionally refuel when part of the way on its journey, and again during the return journey. In this way it will transport the greatest weight of bombs from the smallest possible airfield, and at the same time attain the greatest possible range for the type of aircraft. Such matters involve staff planning in relation to type of target, types and weight of bombs required, range of target from base, weather conditions, route, and whether defence is to be ensured by evasion (that is, speed), by escort, defensive fire power within the bombers, and/or diversionary operations and circuitous route planning. Obviously the unarmed bomber like the Canberra can have its range extended by flight refuelling, but will of necessity have to look for defence to evasion through speed and weather rather than from any other factor.

The advantage conferred by flight refuelling in military air operations is that of a mobile refuelling base. With its adoption it is no longer absolutely essential to push the operational airfields as far forward as may be found possible within the limits of a ground advance. A swift ground advance can be continuously covered by tactical aircraft, without the necessity of moving forward to new airfields in order to keep within striking range. This move can be made at convenience, with no loss of air-to-ground support in the interval.

Before great wars there have been diplomatic (and even aggressive) moves to gain the advantage of bases, through alliances and treaties, and military occupations. This happened in the times of Louis XIV, of Napoleon, Kaiser Wilhelm II and Hitler. It is happening again today. We see alliances, treaties, agreements, leases of bases, and territories overrun, all symptoms of the similar unrest which preceded and accompanied the four historical periods I have mentioned.

In World War II the U.S. Navy developed the Fleet Train to provide exceptional mobility and duration to U.S. Naval Task Forces in the Pacific. The success of that development was striking. It enabled the U.S.N. to cut a line straight across the Pacific, and secure a base within striking distance of Japan. Today, by its speed, aviation can execute the same operation without moving forward from its base, provided it has adequate range. The range requirement can be met in a similar way to the naval use of the Fleet Train by flight refuelling, and applied to the same ends without resort to diplomacy or treaty or enforced occupation of territory. By the use of an *Air Train* no part of Soviet territory is immune from bomb attack by the Western Allies from their existing bases, and this would still apply if the whole of Western Europe were overrun by the Red Army. That, added to the knowledge and experience of the strategic air arm which the Anglo-American air forces alone possess, is the great strategic advantage which flight

A North American RB-45C "Tornado" four-jet reconnaissance bomber being refuelled via the "flying boom." The receptacle is amidships on the fuselage. In the Boeing B-47 "Stratojet" it is in the extreme nose.

A Boeing C-97 "Stratofreighter" military transport is being changed into a tanker by fitting the "flying boom" operator's pod into the space formerly occupied by the clamshell cargo doors. The boom is added later. The whole conversion takes a team of six people less than seven hours.

refuelling confers on the Western Allied Air Forces.

It is in England and America that flight refuelling has been developed. It was first carried out in 1923 as an air show stunt in the USA. General H. H. Arnold (then Major) was concerned in U.S. Army experiments in the same year. General Carl Spaatz (then Major) commanded an Air Corps Fokker monoplane that remained aloft for 150 hours in 1929. In 1930 stunt fliers stayed up for 647½ hours. Europe's first flight refuelling was made by two French Army aviation officers in December 1923. Sqdn. Ldr. Atcherley of the RAF visited the USA in 1930, got interested, and invented a better method, now called the looped-hose system (which is still in use) and carried out experiments at the Royal Aircraft Establishment. Sir Alan Cobham began experimenting in 1932, and to his enterprise and tenacity the present development in England is due. His firm, Flight Refuelling Ltd., owns the rights in the "looped-hose" and "probe-and-drogue" methods of flight refuelling.

After the defeat of Germany in the spring of 1945 the company received a contract to equip 500 "Lancaster" bombers as tankers and 500 as receivers for the long-range bombing of Japan from Burma. But the Japanese war ended before this force was ready, and the RAF never put the looped-hose system into regular operation. In this system the receiver trails a line which the tanker picks up and to which it attaches its hose ; the receiver then hauls in the tanker's hose and attaches it to the reception coupling in the tail of the aircraft. The USAF adopted this system in 1948, and employed it in B-29 bombers, both in the USA and in England. It was used in the round-world flight of the B-50 bomber which left Fort Worth, Texas, on February 26th, 1949 and refuelled in flight at the Azores, Persian Gulf, the Philippines and Hawaii, returning to Fort Worth after flying 23,108 miles non-stop in 94 hours 1 minute.

The USAF suggested the development of a system which would be usable by a single-seat fighter pilot. The probe-and-drogue system was devised by Flight Refuelling Ltd., in four months, and first contact was made in April 1949. In August 1949 a Gloster "Meteor" was refuelled ten times, when it received 2,352 Imperial gallons and flew 3,600 miles without landing. With this system the tanker trails the hose and drogue, and in the drogue is an automatic reception coupling ; the pilot of the receiver aircraft flies up behind, stabs his probe nozzle into the drogue which guides it into the reception coupling. The receiver pilot then presses a button or trigger switch on his control column, thus opening mated valves in the probe and reception coupling, and fuel flows into his tanks through the probe and gallery. This system can be used by any aircraft, fighter, bomber or airliner. It was used by Colonel Schilling and Lt.-Colonel Wm. D. Ritchie in their fighter trans-Atlantic flight. At the 1950 SBAC Display a "Meteor" was shown coupled up to a "Lincoln" tanker. This system has been pictured with three fighters refuelling simultaneously from one tanker, with hoses and drogues trailing from fuselage and both wingtips.

During the past few years Boeing Aircraft Corporation has developed the "flying-boom system," in which a metal tube, extensible from 27 to 47 feet, is carried in the extreme tail of a tanker. The tube can be lowered 34 degrees below horizontal and moved 17 degrees each side of the tanker's centre line. It carries two small vanes, called ruddevators, which enable the boom operator to control his tube aerodynamically. The receiver pilot flies up behind and below the tanker and waits for the boom operator to stab his 4-inch boom nozzle into the 6-inch coupling or receptacle on the receiver aircraft. This coupling may be in the fuselage nose, on the fuselage behind the pilot's cabin or on a wing. The receiver pilot has no control over the operation, but he can break away at any time.

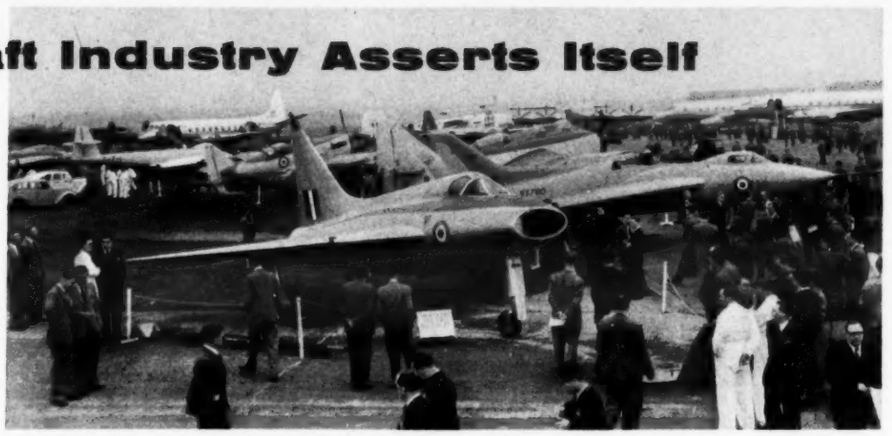
The looped-hose system pumps 200 gallons a minute into the receiver aircraft. The probe-and-drogue transfers three times this flow rate, because the straight trail of the hose and its slightly bigger bore enable larger pumps to be used. With every high-pressure system, the receiver tanks must have anti-surge, automatic shut-off valves. These permit high-pressure refuelling both in flight and on the ground. The large fuel capacity of jet bombers and airliners demands high-pressure refuelling on the ground, for it takes several hours to refuel them if ordinary tanks are fitted. Time for refuelling can be cut to a tenth or less when a high-pressure tank system is installed. Once such a system is fitted, it is a simple matter to convert the aircraft to receive fuel in flight.

The practicability of refuelling aircraft of all classes in flight is now established, but to take full advantage of the civil and military economics of flight refuelling, each aircraft ought to be designed from the outset to fulfil its task in that way. Then maximum efficiency can be achieved. The aircraft need be no larger than is necessary for its payload ; it needs no extra structure weight or size to carry ultra-long-range fuel when airborne fuelling can supply its needs.

The USAF now leads the world in experience of bomber exercises using flight refuelling. USAF bomber Groups with three bomber squadrons of 15 aircraft and one squadron of 20 tanker aircraft are based in England at Mildenhall, Lakenheath, Sculthorpe, Wyton and Bassingbourne with B-50D and KB-29 aircraft ; refuelling equipment was fitted by Flight Refuelling Ltd. In England the "Meteor" and F-84E "Thunderjet" have been fitted with probes, and in USA the F-84G "Thunderjet" is in production with boom receivers. B-29 and B-50 bombers have used both looped-hose and probe-and-drogue. The Boeing C-97 "Stratofreighter" has been adapted as a boom tanker, and the B-36, B-47 and B-45 have all been equipped for flight refuelling. Large sums have been spent on the flying-boom system in America and it is being extensively tested. The probe-and-drogue system has been fully tested. It is slower in operation and the required probe impairs the cleanness of the aircraft, but it possesses the psychological advantage that the receiver pilot makes the contact himself. At the moment the two systems are rivals in the flight refuelling field. The outcome of this rivalry cannot long be delayed, for the adoption of flight refuelling on a big scale seems imminent in the military world, as providing the logical strategic answer to jet fighter and bomber efficiency. Military textbooks will have to be rewritten for the training of air staff officers if these are to be skilful in using this Western Allies current great advantage. And, if they want more revenue to flow into their credit balances, the long-distance airline companies will have to modify their past preference for advance ground fuelling for every flight, and adopt a system which increases passenger and freight ton-miles.

Britain's Aircraft Industry Asserts Itself

*Farnborough, September 11th to 16th**



A view of the aircraft park. The two deltas in the foreground, the Boulton-Paul P.111 at left, the Avro 707B at right.

Atomic explosions on both sides of the Iron Curtain during the past two years are sometimes blamed for the consistent inclemency of 1951's weather. They may be the reason why September, which is known as one of the fine months of Britain's much-maligned climate, failed to live up to its reputation this year.

This did not prevent technicians and others directly, vaguely or not at all connected with aviation from travelling in droves down to Farnborough RAF Station, in Hampshire, between September 11th and 16th. They went to pass judgment on Britain's jet-age progress at the world's oldest aeronautical research station, where "...Cody's Tree"—to which Britain's first practical aircraft engineer, American-born cowboy actor and pioneer pilot Samuel Franklin Cody, used to tether his fragile aircraft—is still visible as a withered relic and where the *Society of British Aircraft Constructors* was holding its *Twelfth Exhibition and Flying Display*. September 11th was the dress rehearsal and technicians' day, and more than 15,000 engineers, mechanics, airline experts and press representatives inspected the modern flying equipment, engines and accessories lined up on the field, demonstrated in the air and exhibited in the huge tent. September 12th, the official opening day, drew a crowd of about 20,000 guests, including delegates to the IATA meeting then being held in London, air force officers, air transport heads and production experts from over seventy countries. This was SBAC's gala day and attracted such illustrious persons as General Hoyt S. Vandenberg, Chief of Staff of the U.S. Air Force, Marshal of the RAF Lord Tedder and many others, and even persuaded Britain's jet hero, Air Commodore Sir Frank Whittle, to interrupt his sick leave in the sun of France. But on the last day, a Sunday, when it was open to the vast public, crowds estimated at 140,000 to 150,000 converged on the field—more than the highlight of Britain's national sport, the football "Cup Final," has ever managed to muster—and thronged through the small tent city of canvas exhibition hall, buffets, press and field offices, first-aid stations, etc.

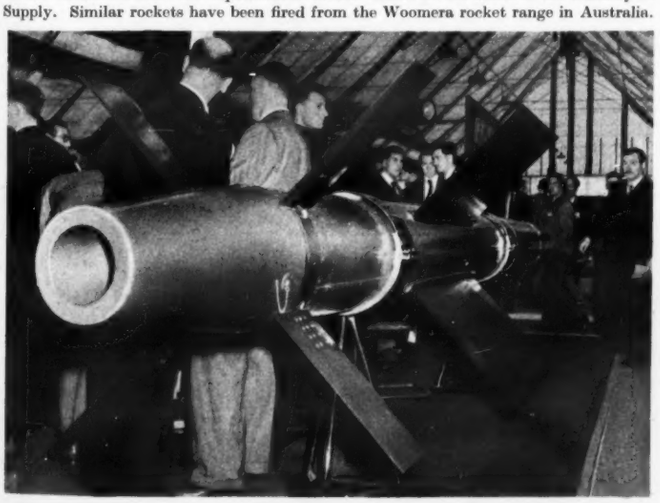
* Characteristics and performance of the aircraft shown at Farnborough were listed in the October issue of "INTERAVIA, Review of World Aviation."

Indoor Exhibits

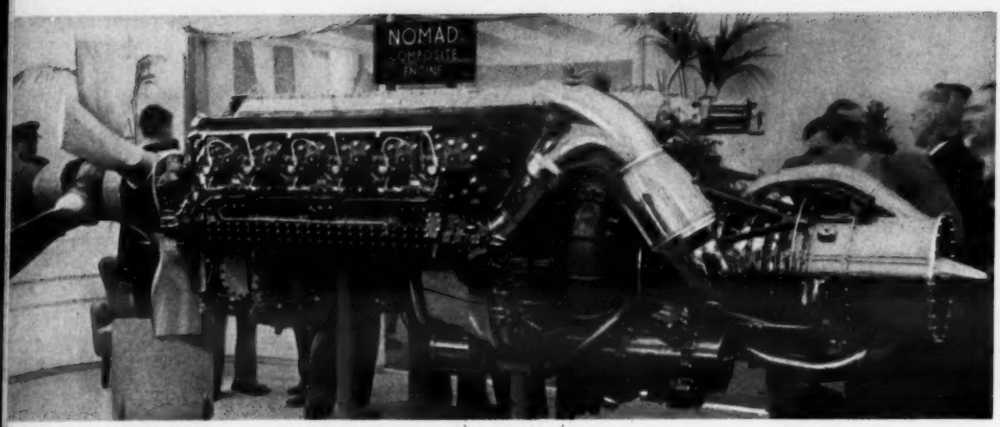
Rain drove us into the exhibition hall directly after our arrival at Farnborough, although we had been making for the aircraft parked along the runways. We emerged hours later, bewildered by enormous quantities of engines, accessories and every conceivable kind of equipment at the stands of over *two hundred* firms. There were *nine piston-engine types* ranging from 145 h.p. to 2,600 h.p., by Alvis, Blackburn (Cirrus), Bristol, de Havilland and Rolls-Royce ; *six propeller turbines* delivering 1,320 to 3,600 h.p., by Armstrong-Siddeley, Bristol and Rolls-Royce ; *six straight jets* of 3,600 to 7,200 lb. static thrust, by Armstrong-Siddeley, de Havilland, and Rolls-Royce ; *two rocket motors,* the de Havilland "Sprite" and the Armstrong-Siddeley "Snarler." All these were known. The greatest novelty was Napier's 3,000 h.p. (plus 320 lb. thrust) "Nomad" composite engine, which comprises a supercharged 12-cylinder flat-twelve Diesel engine driving half of a contra-prop ; exhaust gas from the engine is fed into a gas turbine, the power from which is delivered to the other half of the propeller. The arrangement is designed to provide maximum fuel economy, but present fuel consumption (presumably at take-off power) and power/weight ratio, which are not superior to that of American radial engines in the same power bracket, show that the engine is still at an early stage of development.

Il would be quite impossible to describe the thousands of items shown in the hall or even to mention only the names of the manufacturers. Aircraft chairs, metals, de-icing equipment, servo motors, radio and communications equipment, radar, bonding materials... A few

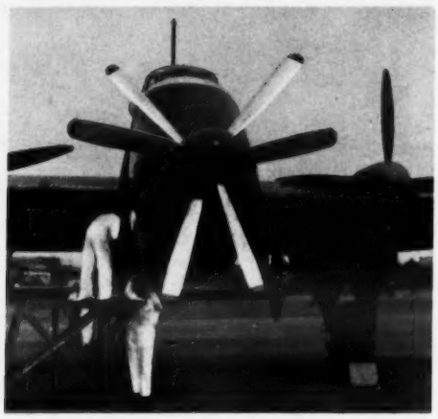
In the exhibition hall : the experimental bi-fuel rocket on the stand of the Ministry of Supply. Similar rockets have been fired from the Woomera rocket range in Australia.



One of the stands in the exhibition hall.



The major novelty in the hall : the Napier "Nomad" composite engine.



"Nomad-Lincoln."

particularly "juicy" exhibits may be picked out at randon. At the stand of the *Ministry of Supply* was an experimental bi-fuel rocket which, with an estimated performance of 2,000 m.p.h., was "the fastest aircraft in the show" (it didn't fly, of course). The missile is intended for the study of problems of aerodynamics, propulsion, structures.—A delta-wing made of plastics, developed by the Ministry's Royal Aircraft Establishment at Farnborough aroused much interest. The wing is moulded to shape and reinforced at points of high stress.

We were fascinated by the ejection seats of *Martin Baker Aircraft* and *ML Aviation Co.* The seat manufactured by the latter company makes provision for an unusual range of emergencies. It ejects the pilot at a speed of 80 ft./sec., which is enough for the fastest fighter ; the ejection cartridge is inserted into the gun just prior to use to prevent inadvertent ejection (as a result of enemy fire, etc.) ; a special underwater cartridge is fitted for the event of a ditching ; etc. The seat was shown with a dummy pilot strapped in, with crash helmet, goggles, parachute, earphones, microphone, pressure suit and several other proofs of our advanced civilization. We thought that a naked savage no doubt feels much more comfortable...

Normalair Ltd. had a wide range of cabin air conditioning and pressurization equipment, *Ferranti Ltd.* exhibited their Distance Measuring Equipment for air navigation (D.M.E.), *Redifon* demonstrated its Electronic Flight Simulator (a "synthetic" crew trainer, British version of the Curtiss-Wright Dehmel trainer), and the stand of *Dunlop Rubber* was filled with tyres, wheels, brakes, de-icing equipment, windscreen wipers, etc.

As we emerged from the tent we noticed that the rain had stopped, and we directed our steps to the Press Tent for refreshment before moving over to the aircraft gleaming in the watery sunlight.

Transports

No new civil transports came to Farnborough to make their public bow this year. None were expected—after all, no airline changes its equipment every year, and the aircraft demonstrated at the past two shows are only now approaching the practical operational stage.

The aircraft park was dominated by the huge *Bristol "Brabazon"* experimental type, and queues of visitors lined up for a "Cook's tour" of the giant. Leaving it aside, we took the opportunity of inspecting the interiors of the three machines next on the equipment programme of the British airline corporations. The sleek twin-engined, high-wing *Airspeed "Ambassador,"* which at last is getting over its teething troubles, looks like a real utility transport with its 47 seats, 18 of which face aft ; a large number of them are arranged in rows of five (two on one side of the aisle, three on the other). As we were testing the adjustable back rests, we found ourselves sitting next to Peter G. Masefield, the young (36) Chief Executive of British European Airways. Amiably he replied to our questions : "We are going to make a lot of money with this aircraft... The pressurization is particularly pleasant, ground level at 12,000 feet on short runs, 5,000 feet at 20,000 ft. on longer ones... The first will go into service in October and five will be in operation by November; the rest of the twenty will follow at a rate of one month..." One of our impressions was that the air hostess will have to accomplish a lot of legwork down that long aisle on the shorter stages... The passenger seats of the jet-propelled *de Havilland "Comet"* and the *Vickers "Viscount"* turboprop airliner are the last word in comfort. The backrest slides back and downward, the seat downward and forward, and in the extended position you still have a lot of knee and leg room left.

Of the three machines, only the graceful "Viscount" was shown in flight. The second, less successful British medium-stage turboprop liner, the *A.W. "Apollo,"* did not show up, but that perennial propeller-turbine conversion, the *Handley Page "Hermes V,"* was demonstrated in flight for no discernible reason, since BOAC's chosen long-range turboprop liner is the *Bristol 175 "Britannia,"* which was not ready for this year's show.

We also ventured into the *de Havilland "Dove"* and *"Heron"* light transports, which are fitted with fixed seats comfortable enough for short trips. But somehow we did not feel quite at ease—perhaps we have an inclination towards claustrophobia. Other small transports shown were the *Handley Page "Marathon 1"* and the *Percival "Prince."*

Of the two available British cargo transport types only the giant four-engined *Blackburn & General Aircraft "Universal,"* was shown in flight ; it sported a new bogie-type undercarriage and on Monday, the day before the show, had given a demonstration disgorging a "Land

The veteran Bristol "Brabazon" brooded over the aircraft park. Hundreds lined up for a "conducted tour" of the giant.

Vickers "Viscount 700."

De Havilland "Comet" with bogie-type undercarriage and boundary layer fences on the wing.

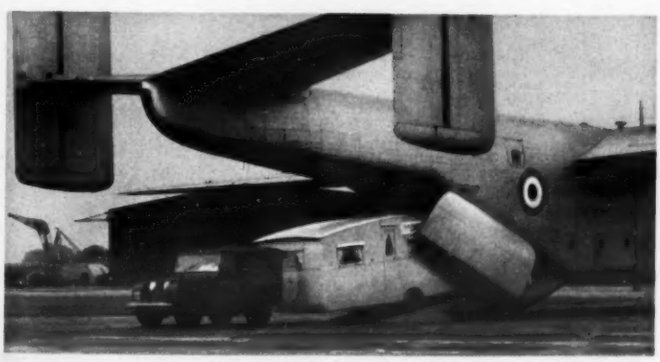
Airspeed "Ambassador" displays a new version of the "orange-peel" cowling.

Rover" (British equivalent of the U.S. jeep) drawing a huge camping trailer. On landing it came to a rapid stop with its four reversible airscrews and even started taxiing backwards—a weird sight for such a large aeroplane. The veteran *Bristol 170* "*Freighter*" was there, too, this time housing a Bristol 171 helicopter. A novel feature was the transparent panels in the bottom of its clam-shell nose doors—probably to make the type suitable for air survey work.

Speaking of helicopters, we half expected the *Bristol 173 inter-city type* to appear, but apparently it had not accomplished its ten hours' flying to qualify it for the event. Only the five-seater *Bristol 171* "*Sycamore*" and the four-seater *Westland-Sikorsky S.51* danced their usual

The de Havilland "Heron" four-engined small transport taking off.

Handley Page "Hermes 5" experimental turboprop airliner.



The Blackburn & General Aircraft "Universal" cargo transport disgorges a "Land Rover" and a camping trailer.

ballet. In the exhibition hall, however, *Fairey* had a model of its "Rotodyne," an inter-city aircraft featuring two piston engines and propellers for forward motion, a small wing, rotor and twin fins. *Westland Aircraft,* who manufacture the S.51 and S.55 under licence, announced three projects, the W.80 twenty-passenger inter-city transport, the W.81 thirty-passenger type ("Double Mamba" engine), and the W.85 troop carrier (100 troops, AS "Twin Adder" blade-tip jets).

Fighters and Bombers

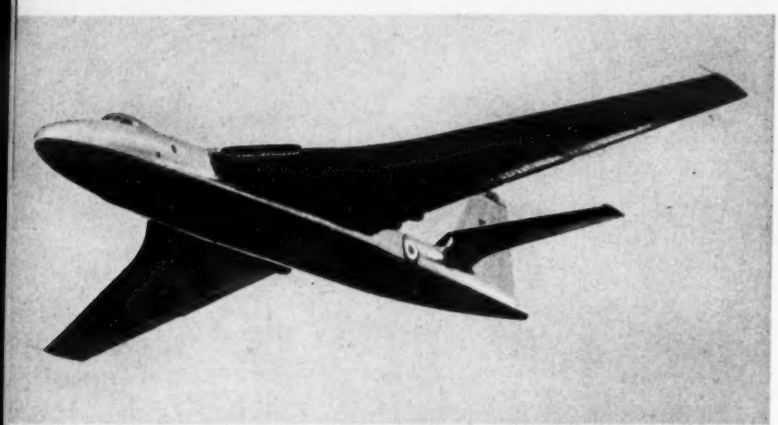
The four most striking exhibits of the event appeared during the demonstration of military combat aircraft. They were striking not only because of their performance, but even more because they have been ordered into production for the RAF or the Royal Navy. They are the Vickers "Valiant" four-jet bomber, Hawker P.1067 and Vickers-Supermarine "Swift" swept-wing jet fighters and the Vickers-Supermarine Type 508 twin-jet naval fighter.

This enumeration alone points to one interesting fact, namely, the vast importance which the two Vickers design teams headed by Chief Designer George R. Edwards and J. J. Smith have given to Vickers-Armstrongs in the aircraft engineering field. In addition to the three modern types mentioned above, Vickers are building the sleek "Viscount" transport and the "Attacker" naval fighter as well as the "Varsity" crew trainer and other, minor types.

The most astonishing individual performance no doubt was that of Squadron Leader Neville Duke, who stole the show by switching on his afterburner and "beating up" the airfield in the *Hawker P.1067* prototype fighter at a height of about 100 feet at between 680 and 700 m.p.h., faster than any aircraft has ever been demonstrated in public. We were sitting on the grass near the runway trying to get a photo of the aircraft as it shot by, but we weren't successful. Duke came past directly over our head—one moment he wasn't there, the next he was gone. In between, there had been an ear-splitting explosion, followed by a long "whoosh" and kerosene fumes drifting along the field. The shock wave knocked the "mike" from the announcer's hand and blew hats in all directions. A little earlier in the show commentator Oliver

Bristol 170 "Freighter" (outside), Bristol 171 "Sycamore" helicopter (inside).

The fastest aircraft of the show : the Hawker P.1067 fighter beating up the field.



Beauty Queen : the big Vickers "Valiant" four-jet bomber was easily the most graceful military aircraft at Farnborough.

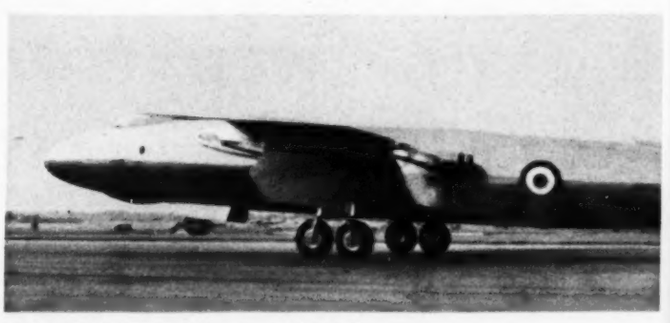
The "Valiant" lands.

Stewart had dubbed Neville Duke a "quick-change artist," as he had demonstrated the *Hawker P.1052* "navalized" fighter prototype, which probably will remain in the prototype stage, with equal verve and virtuosity, but rather less speed.

The *Vickers "Valiant"* four-jet swept-wing atom-bomb carrier (R. R. "Avon" engines), confidently flown (without the bomb!) despite its newness by G. R. Bryce, Chief Test Pilot for the Weybridge Works of Vickers-Armstrongs, impressed the audience by its clean lines, noiselessness and manoeuvrability. It has swept wings, does away with engine nacelles, pods and other excrescences by having its jets completely submerged in the wing, so that it looks almost like a huge but very graceful glider. It was never flown full-out, probably for security reasons, but no doubt its swept-wing aerodynamic sleekness and four 6,500-lb. "Avons" give it an excellent turn of speed—beautiful aircraft are nearly always efficient. Range is reported to be about 5,000 miles with wing-tip tanks. If it is true that the unarmed "Valiant" is the fastest aircraft of its class in the world and has a normal operating altitude of 60,000 feet—higher than the operating levels of the American B-36 or of any known fighter or the effective tactical altitude of the most modern anti-aircraft gun—its official description as the "most powerful offensive weapon ever produced" may be justified. Points of interest are the huge landing flaps and the four separate main wheel legs. The production order for the "Valiant" is said to be quite small (about 20) but is to be increased shortly. Meanwhile, the "Valiant" had been inspected at a private show prior to the SBAC Display by USAF Chief of Staff General Hoyt S. Vandenberg, and the USAF is said to be considering production of the type under licence in the USA. However that may be, it is known that Chief Designer Edwards left for the USA on September 18th to address the Society of Automotive Engineers in Los Angeles between October 3rd and 6th. He was to return to England at the end of October and therefore would have plenty of time to discuss production problems.

Another brand-new type from the Edwards stable was the *Vickers-Supermarine Type 508*, which had just completed its "qualifying time" of ten hours and was flown carefully but competently by Lt.-Commander Michael Lithgow, Supermarine Works Chief Test Pilot. Described as the "world's fastest naval fighter," it has two "Avon" jets side-by-side, straight, very thin wings and a butterfly tail.

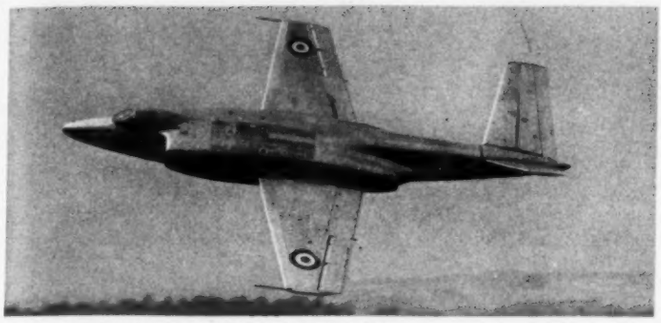
Type 508 has aroused a considerable amount of controversy. Why two "Avons" and a straight wing ? Some say the 508 is an old specification (as its number implies—latest known Supermarine models go to beyond 538), hence the straight wing. Others believe the aircraft to be sonic or supersonic, therefore its Mach troubles will arise anyway, and perhaps it is best to get them over early. Still others even think that the straight wing is the first sign that sweep-back may be on its way out. Climb must be the best yet, as the airframe cannot be more than half as heavy as the "Canberra" bomber and the power is the same. The butterfly tail is novel on a combat aircraft, but the tail surfaces are effectively removed from the jet stream and the arrangement should pay dividends in drag reduction. At present the aircraft is a single-seater, but another crew member is likely to be added to operate the radar equipment. Even though the aircraft no doubt is an interceptor, and will be radio-guided during a rapid climb to its prey, it will also be



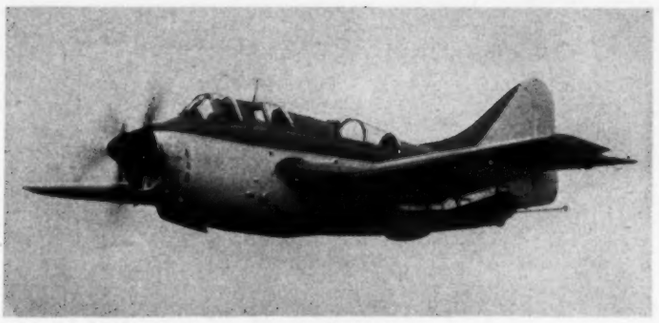
The "Valiant's" flaps and four-strut main landing gear.

Vickers-Supermarine "Swift" fighter.

Ground-attack "Meteor."



Vickers-Supermarine Type 508 twin-jet naval fighter.



Fairey "Gannet" anti-submarine aircraft. Note flaps.

Type 508 lands.

Vickers-Supermarine Type 538 "Attacker."

capable of covering longer stages, cruising on one engine only. — One apparent weakness seems to be poor accessibility to the two engines.

Incidentally, Type 508, which has a typical but enlarged "Attacker" fuselage, reminded us of the Lockheed XF-90 twin-jet penetration fighter, which was evolved from the basic F-80 "Shooting Star."

One Vickers aircraft which was represented by another was the "Avon"-powered *Supermarine "Swift"* fighter, the second swept-wing fighter on order for the RAF (the first : Hawker P.1067). The only "Swift" so far completed crash-landed in a field at Chilbolton, Hants., three days before the Display and could not be repaired in time, so that its place was taken by its prototype, the "Nene"-powered *Type 535*, flown by D. W. Morgan. The pilot tried hard during a fast pass to imitate Neville Duke in his P.1067, but although the Type 535 was the second-fastest aircraft of the show, the difference in power most definitely told.

On behalf of the Navy two turbine-powered attack aircraft were put through their paces, the torpedo-toting *Westland "Wyvern 4"* strike fighter (on order in quantity) which first flew two years ago and still is one of the largest bundles of power to be handled by one man (3,650 e.h.p. "Python" turbo-prop), and the *Fairey "Gannet"* anti-submarine aircraft. The "Gannet" created a flutter by taking off with half of its engine and contra-prop—i.e., one of the "Double Mambas" and its propeller—inoperative.

Military Workhorses

In addition to the new and in part sensationally fast aircraft, the SBAC Display featured a number of "workhorses" which could not claim to be capable of competing with the newer types. In particular, the Show underlined the tendency to use older fighter designs with speeds below those of the latest types chiefly for rôles not requiring the very highest flying speeds.

Gloster's ground-attack "Meteor" was the most remarkable example of this trend—remarkable not only through its performance but also because of the way it was handled in flight. Loaded down with twenty-four 95-lb. rockets, wing tip drop tanks and four 20-mm rockets (it has been nicknamed "the Reaper"), the aircraft was flown vertically upwards until it hung literally suspended for a moment, then it came tumbling down wing-tip over wing-tip in a "double cartwheel." The manoeuvre

Torpedo attachment on the Westland "Wyvern" strike fighter. The rear stabilizer and fin detaches itself when the "tin fish" hits the water.

Fairey "Firefly Mk.7" anti-submarine aircraft. Sono-buoys are housed in streamlined boxes.

De Havilland "Sea Venom" naval all-weather fighter.

—the "first new aerobatic in twenty years"—was achieved by Pilot Janusz Zurakowski, former Squadron Leader of the Polish Air Force fighting with the RAF, by shutting off one of the "Meteor's" engines at the top of the climb and pulling over on the other. The tip tanks may help by preserving the tip flow at the stall, but the manoeuvre is obviously tricky, as it never came out twice the same and even failed on one occasion.

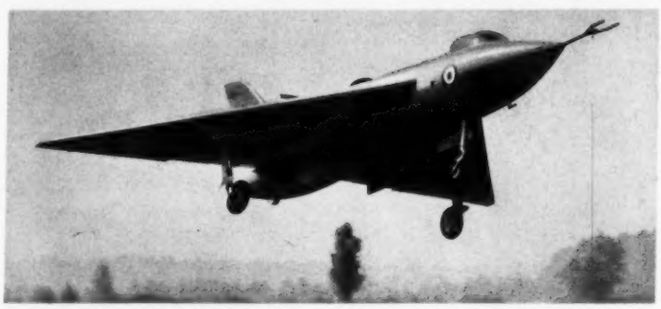
Other aircraft of the "workhorse" group were the *Armstrong-Whitworth/Gloster "Meteor" NF Mk. II* two-seater night fighter, now in production for the RAF and European air forces, and the *Vickers-Supermarine "Attacker" Type 538*. The latter is a conversion of the "Attacker" four-cannon naval interceptor into a long-range strike aircraft by the addition of a huge belly tank, four 95-lb. rockets and two 1,000-lb. bombs (the latter can alternatively be replaced by tip tanks and four more rockets) ; the aircraft is in production for the Navy.

Squadron Leader John Derry, de Havilland test pilot and ace aerial showman, once again put his amazing stamina to the test by waltzing his *D.H. "Sea Venom" Mark 21* two-seater naval night fighter across the field with his usual precise, fast and furious manoeuvres and featuring his famous "vertical reverse."

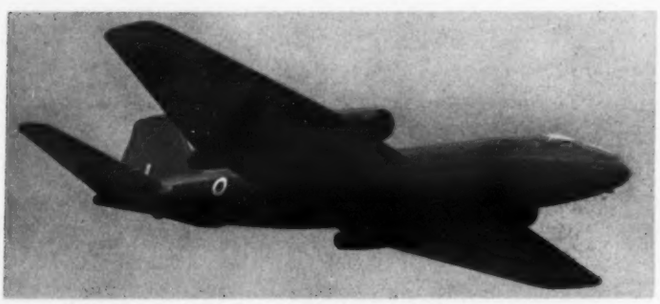
Incidentally, we have been wondering why it is that Britain's test pilots seem to be predominantly tall and thin, with deceptively mild and ascetic faces, whereas American test pilots are mostly of the short, tough, stocky, rollicking type. It can't be the lack of steak in Britain alone. Apparently toughness comes in every shape.

To finish with our list of workhorses, we still have to mention three types : (1) the *Fairey "Firefly" Mark 7* three-seater anti-submarine aircraft, a stand-in pending delivery of the "Gannet"; the Mark 7 carried sono-buoys in two airfoil-shaped boxes under the wings, in addition to a number of rockets ; (2) the *English Electric "Canberra"* twin-jet bomber, on the first days in the guise of the P.R. Mk.3 photo-reconnaissance version, later in that of the B. Mk.5 bomber version ; both performed the "Canberra's" usual fighter-like manoeuvres ; (3) the *Avro "Shackleton"* four-engined long-range patrol bomber developed from the war-time "Lancaster" and "Lincoln."

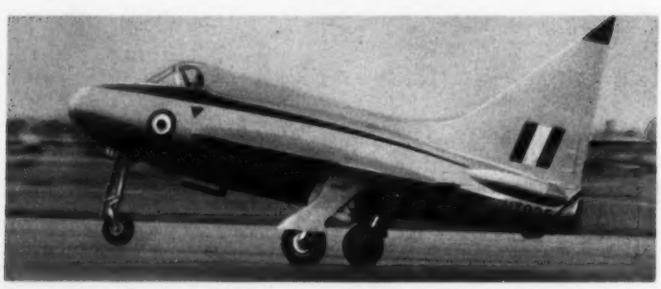
Avro 707B delta-wing.



Note air brakes on Avro 707B delta.



English Electric "Canberra" photo-reconnaissance aircraft.



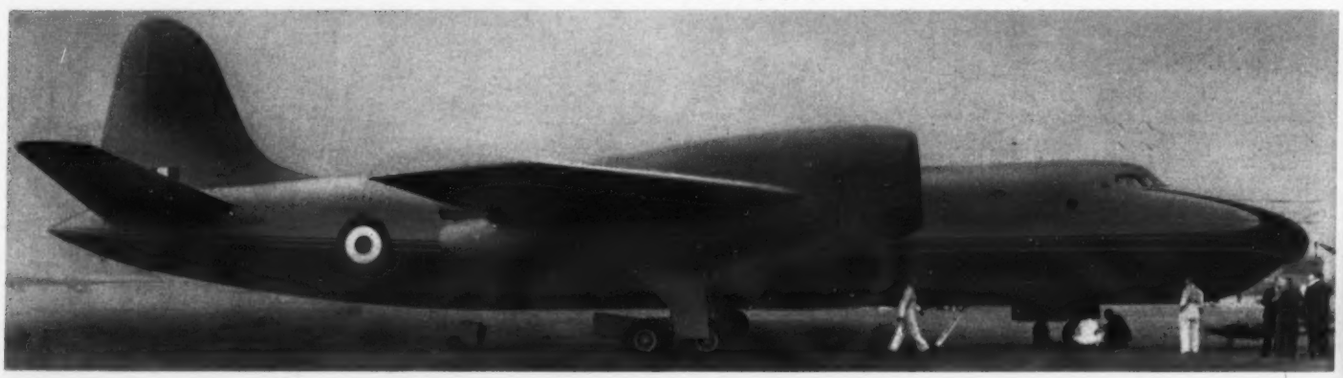
Boulton-Paul P.111 delta takes off.

Experimental Aircraft

The 12th SBAC Display also produced a normal crop of experimental aircraft. But apart from machines transporting around, or being transported around by, engines for which they were not designed, this year's Display produced two pointers to the future—the *delta-wing experimental types*. An *Avro 707B* and the *Boulton Paul P.111* showed off their manoeuvrability at high and low speeds. They seemed quite stable in the air, except that the Avro occasionally seemed to find it difficult to keep straight. On the other hand, its roll was more rapid than that of the P.111. Landing seemed to be fairly slow and easy, in spite of the high angle of incidence, and quite short with a brake parachute. The Avro 707B has its air intake on the back ; a sister ship with wing root intakes, the *707A*, was in the static aircraft park.

Two interesting experimental aircraft failed to make the show : one was Britain's No. 3 delta-wing, the *Fairey FD-1*, which had completed nine flights but had not reached its Farnborough ten hours. Faireys are

The huge proportions of the Short SA/4 four-jet bomber are revealed in this side-view.



Star Performers

Hawker's Neville Duke, 29, Fastest man of the show (P.1067 fighter).

D.W. Morgan, 28, of Vickers, second-fastest on the Vickers 535 prototype.

G.R. Bryce, 30, had the most elegant mount, the deceptively graceful Vickers "Valiant" atom-bomber.

Janusz Zurakowski, 37, invented the "double cartwheel" with his Gloster "Meteor" ground-attack fighter.

Michael J. Lithgow, 31, demonstrated the butterfly-tailed Vickers 508 naval fighter.

John Derry, 29, displayed his usual verve and enthusiasm in the de Havilland "Venom Mk.20" naval fighter.

H. "Timber" Wood, 49, flew the show's heavyweight, the Blackburn "Universal Freighter."

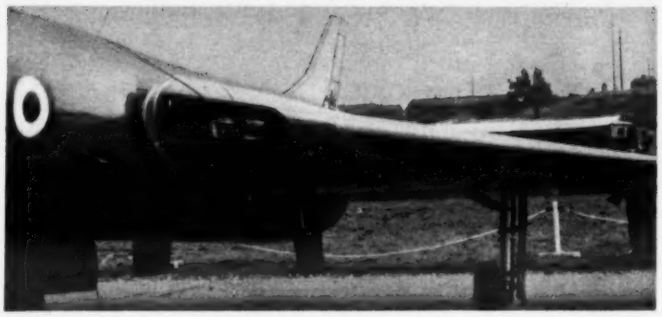
Richard B. Prickett, 29, of Armstrong-Siddeley, "made like" Toscanini before flying the "Sapphire Canberra."

Roland J. Falk, 36, the most "futuristic" pilot in the Avro 707B delta-wing.

Richard Gordon Slade, 38, Chief Test Pillot for Faireys, demonstrated a threat to submarines in the "Gannet."

Thomas William Brooke-Smith, 33, of Short Brothers and Harland, Ltd., put the big Short SA/4 four-jet bomber through its paces.

W.H. Else, about 29, stalked the skies in the Meteor N.F.11 night fighter of Armstrong Whitworth Aircraft, now in production for Western Eropean defence.



Avro 707A delta-wing has wing-root air intakes.

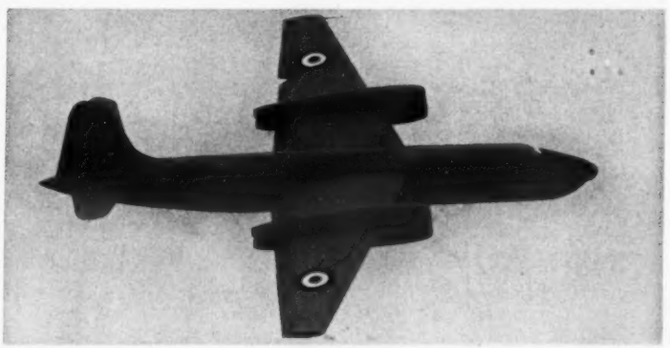
said to be very pleased with it, but it lands faster than the others. The second is the *Handley Page H.P.88 "crescent-wing" aircraft*, which crashed shortly before the Show. A new one is under construction.

Hawkers showed their experimental *P.1072* fighter—in reality a conversion of the old P.1040 with a 2,000 lb. Armstrong-Siddeley "Snarler" rocket motor in the tail for emergency thrust. The "Snarler" may later be added to the P.1067.

The biggest new prototype of this year was the *Short S.A.4* four-jet bomber ("Avons"), which has its engines in two vertical pairs. It was built to the same specification as the Vickers "Valiant," but lacks the latter's delicate lines and took much longer to take off. It is not scheduled for production.

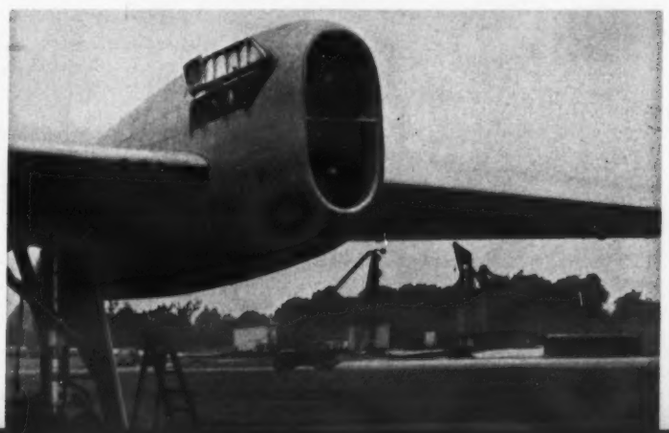
A *"Canberra"* light bomber had been fitted experimentally with two A.S. "Sapphire" engines of 7200 lbs. static thrust each (could this be for the benefit of American guests, since the "Sapphire Canberra" is to be built in quantity in the USA?) and gave an even more impressive demonstration of manoeuvrability than the "Avon Canberra." On the first day one of the engines failed on take-off, and the aircraft began to swing madly on the runway. At one time it made the press photographers scuttle in every direction, in the good old Arturo Toscanini manner. The "Sapphire Canberra" installation had its "pendant" in the "Sapphire Meteor," which flew in 1950, but was confined to the static show this year. One Sapphire test-bed which was missing was the "Sapphire Hastings."

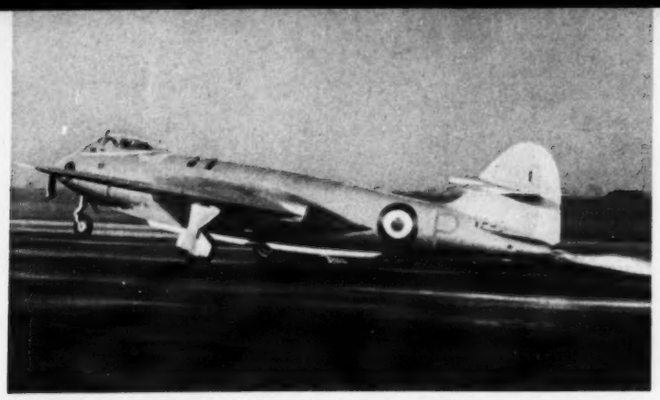
Other experimental aircraft were the *"Proteus Lincoln,"* a "Lincoln" with two Bristol "Proteus" turboprops in place of its two outboard "Merlins"; the *"Mamba Marathon,"* a special version of the H.P. "Marathon" four-engined light transport with two A.S. "Mamba" turbines turning de Havilland reversible-pitch airscrews; the *"Nomad Lincoln,"* which in addition to its four "Merlins" had a Napier "Nomad"



Short SA/4 four-jet bomber.

Two "Avons" in each nacelle of the Short SA/4.





Hawker P.1072 experimental fighter with the Armstrong-Siddeley "Snarler" auxiliary rocket motor. Aircraft was not flown at Farnborough. P.1072 is conversion of the old P.1040 prototype.

Tail end of P.1072, enclosing "Snarler" rocket.

composite engine in its nose; the perennial *Avro "Ashton"* experimental four-jet transport type of the Ministry of Supply; the de Havilland *D.H.112 "Venom I"* with afterburner; and the de Havilland D.H.115 "Vampire Trainer."

We won't leave the experimental aircraft without mentioning two unscheduled performances. The first occurred on the day before the show, when we were stooging around to get a picture or two of aircraft without having to photograph a dozen visitors as well. An aircraft was doing practice landings, and somehow it looked strangely familiar, but not quite. We recognized it then—it was a pre-war acquaintance, the pretty little *Reid & Siegrist "Desford"* twin-engined trainer. It had been converted, and the practising pilot was doing his manoeuvres in a *prone* position. He didn't look particularly comfortable.

The second unscheduled performer appeared on the SBAC gala day. A "Sea Vampire" fighter of the Empire Test Pilots School, which has its headquarters at Farnborough, carried out a trial landing on a pneumatic "carpet" set up on a part of the field removed from the SBAC show. The aircraft came in at very low speed in a markedly tail-down attitude with its arrester hook lowered and came to a stop on the rubber mat apparently within a distance of less than ten yards. From afar the hook seemed to engage an arrester cable located somewhat above the deck, simply stalling the aircraft on to the inflated rubber surface. No damage was discernible from the SBAC side of the field, but it is understood that in some earlier experiments the aircraft broke just aft of the cockpit. Since the aircraft was brought from its minimum speed to a standstill in fractions of a second, the deceleration to which the airframe and the pilot are subjected must be extremely high (presumably between 8 and 12 g). The landing deck itself seemed to consist of a carpet of several layers of inflatable rubber ballonets such as are used for the lifting of heavy aircraft after a belly landing; this obviously is a provisional arrangement. The Royal Air Force, too, is reported to be interested in this development as a possible solution of the air base problem in the vicinity of densely populated areas. Wheel-less aircraft, probably fitted with a fuselage skid, would be launched by catapult and land on these small, inexpensive landing sites. One problem in this connection would no doubt be the quick removal of landed aircraft to make room for other machines rapidly succeeding each other with fuel tanks more or less empty.

*

British post-war living conditions have virtually put an end to private flying in England, and it is therefore not surprising that very few British *light aircraft* have made their appearance in the last few years. The 12th Display was merely a repetition of earlier ones in this respect: apart from the Auster "Aiglet," the Auster "Ambulance/Freighter" and the Auster Model S, nothing new appeared in the market, but it is understood that a few things are "cooking" in the shops of smaller companies. The usual impressive slow-flying performance was given by the *Prestwick "Pioneer"* utility transport prototype. War-time and even post-war *trainers* have given way to a new range of types, from the D.H. "Chipmunk" elementary type, the Percival P.56 "Provost" basic trainer to the Percival P.57 "Sea Prince" and Vickers "Varsity" crew

The "Proteus-Lincoln," with two Bristol "Proteus" propeller-turbines (outboard) landing. The Bristol "Brabazon" is in the background.

trainers. Whatever has happened to the Boulton Paul "Balliol" and the Avro "Athena," both of which showed much promise a few years ago?

*

Those 150,000 people who left Farnborough on the evening of September 17th certainly were proud of what their own aircraft industry had produced. Probably they had more right to be proud than they suspected. The 12th SBAC Display has shown proaf of the beginning of a resurrection of British air power, based on Britain's pioneering achievements in the gas turbine development field. Since the end of World War II, British civil aviation has either had to "make do" with stop-gap aircraft or to buy modern equipment abroad. The military services, too, have been largely using equipment built or at least designed in World War II, and the recent combat testing of the "Meteor" against the MiG-15 in Korea (and, after all, even the MiG is old stuff for the Russians now) has been a rude awakening. But the past six years have been a period of slow development and engineering, and this work is now bearing fruit. New, modern, turbine-powered transports will go into service on the British air routes over the next three years. New jet-bombers and jet-fighters are going into production for the RAF and the Navy—and the prototypes of still newer ones will probably take their first public bow at the 13th SBAC Show next year.

Percival "Provost" trainer.

Auster B/4 light ambulance-freighter.

Saint-Exupéry as Inventor

BY DR. GEORGES PÉLISSIER, ALGIERS [1]

"Grown-ups love figures" (Le Petit Prince)

It was almost inevitable that a man of such an exuberant and original mind and such a wide culture should also become an inventor.

He had a very lively taste for the exact sciences. It is an interesting fact that the commander of the "Citadelle" had no friends among generals or governors, or even among logicians. His only real friend was the geometrician.

A. R. Métral, Professor at the Conservatory of Arts and Professions, has published an excellent study [2] on Saint-Exupéry as an inventor. It discusses in every-day language the patents taken out by Saint-Exupéry during the last few years of his life. He was a prolific inventor, obtaining no fewer than eight patents in two years, between October 8th, 1937, and July 28th, 1939.

All these patents are for devices connected with flying : landing equipment for aircraft, goniograph, lift and propulsion system for aircraft, route tracer, checking instrument for engines in flight, starter for engines, measuring method for D/F indicators.

The route tracer provided an original solution for navigation problems for both ships and aircraft. And a few years earlier Saint-Exupéry had failed to obtain the air navigation instructor's certificate at Brest ! [3]

Whatever may be the practical value of these patents, and their ease or difficulty of realisation, the fact remains that he "discovered theoretical and practical solutions to difficult problems, without a laboratory to help him, when eminent technicians and even scientists were merely engaged in preliminary studies" (A. R. Métral). He was in advance of his time. This is obvious from his ideas on lift and propulsion for aircraft. He had foreseen jet engines.

As Métral shows, the peculiarity of his creative imagination is that although he handled the language of mathematics with sovereign ease he constantly sought to "replace the aridity of a purely mathematical demonstration by an explanation based on formal logic." He "reasoned much more by philosophic intuition than by physical analysis."

The universality of this intellect, which embraced all that was human and in which the most diverse elements combined to form a harmonious whole, comes clearly to light here.

He frequently confided his thoughts to me. Up to 1937 he never spoke about scientific research. The first time he mentioned this subject was one afternoon in 1937 at his home in Place Vauban. He was expecting a member of the Polytechnic who was to check his calculations. He handed me a brochure. It was "Blind Landing by Aircraft," his second patent.

If my memory serves me rightly, he had had a curious little adventure with his first patent. Either through forgetfulness or through ignorance he had failed to renew his patent rights and the patent had become public property. One day he received a friendly letter from a firm with whom he had never had any dealings. They told him that since they had made a profit out of his invention they felt it only right that he should have his share, and sent him a little of the money they had made thanks to his ingenuity. He considered they had behaved very decently.

There was also a tenth patent which had not been published when Métral's account of the first nine, to which I have referred above, appeared. Because of wartime legislation this tenth patent, although applied for in two letters of February 19th and 29th, 1940, was not granted until March 17th, 1947. It was published on August 20th, 1947, so that it is now permissible to discuss it.

It covers a "new method of direction finding by electro-magnetic waves." The principle is as follows :

To locate a point of unknown position in relation to one or more known fixed points, a radio-electric signal or pulse is transmitted from the unknown point and re-transmitted automatically from the fixed point or points, but on a different frequency (so as not to be confused with the echoes). The interrogating station receives the return signal by means of a cathode ray oscillograph giving a circular diagram. The outgoing and the return pulse are indicated on the circumference of the fluorescent screen by a fixed radial marker, a light blip or an interruption, according to the device chosen.

The space between the transmission and reception pulses on the diagram enables the required distance to be measured. This space represents a time interval which is the sum of the delay due to the inertia of the transmitting and re-transmitting stations (a fixed delay) and the variable time taken by the pulse in question on its outward and return trip. Electro-magnetic waves, as is known, are propagated at the limit speed of physical substances, i.e. 186,000 miles per second. If the speed of rotation of the vector has been adjusted at 1000 revs. per second in the cathode ray oscillometer, a distance of 10 km. between the transmitter and the re-transmitter will correspond to one fifteen thousandth of a second, and will be measured by one fifteenth of a turn of the circle, i.e. by the space of 24 degrees.

As always happens, where patents are concerned, this last one was contested by numerous foreign patent-holders. One patent (French) out of twenty-one, was contested by . . . Germany. The other patents, British, American or Australian (one only) were contested by Germany, Britain, the USA and Australia. M. Gunty and M. Savornin, professors of the Faculty of Science at Algiers, and Captain Israël, chief pilot of Air-Algérie, have been good enough to investigate these claims with the aid of the documentation provided by the Compagnie des Compteurs de Montrouge. Only one patent, an American one taken out by Stuart W. Seeley, would appear to be identical, with Saint-Exupéry's, but its date of application, February 28th, 1941, is a year later than his (February 19th and 29th, 1940). Obviously then, Saint-Exupéry was the first. My sole object here is to show the originality of his mind.

The first use of electro-magnetic waves was made in 1934 and 1935. The first mobile transmitter-receiver for the detection of obstructions, designed by Henri Gutton, was installed in the "Normandie" in 1938 to detect icebergs, and it is well known that it was only during the war of 1939-1945 that radar really came into use. We can well say that once again Saint-Exupéry was in the vanguard of the scientific thought of his time.

Saint-Exupéry's patent had been applied for, let us repeat, on February 19th and 29th, 1940. To my knowledge the device it describes has not been produced in France. And yet with this instrument distances from fixed points can be read off directly, without adjustments.

The invention covers five methods of navigation which Saint-Exupéry describes in detail :

1) method of general navigation with the aid of two base stations ;
2) method of navigation with the aid of a single base station ;
3) method of navigation along a given route, on a beam from two base re-transmitter stations, one on either side of the route ;
4) method of approaching an airport ;
5) method of guidance towards an objective by means of two base stations alongside the route passing through the objective and a third station arranged to permit of sighting operations.

A number of variants can be envisaged, working on the above principles. This brief outline of the applications of his patent shows that Saint-Exupéry's ideas are still up-to-date.

*

On at least two occasions in Algiers, Saint-Exupéry and I had a long conversation on the physiology of the eye and the theory of dazzling. One afternoon he described his idea to me, drawing me a

[1] This article is composed of fragments taken from Chapter 15 of a book shortly to be published by Flammarion : *The Five Faces of Antoine de Saint-Exupéry — Pilot, Writer, Man, Inventor, Magician.*

[2] *Confluences*, Vol. VII, No. 12-14, pp. 93-108.

[3] He had been classed eleventh out of thirteen, and three were failed. The course was given by Chassis under the control of Captain Hamburger, and not by Demougeot as has earlier been stated in error.

diagram and writing a description which I have in front of me now : it was the principle of his system of night camouflage through dazzling which he submitted to the military authorities during the campaign of 1939-1940. The idea had come a long way, by the following stages.

When he first carried mail in the Argentine, on the Buenos Aires—Santiago de Chile service, he had heard so much about the tremendous impression made by the Cordillera in the Andes that he imagined himself threading his way painstakingly, like a winged insect, among giant crests and peaks. The aircraft's ceiling was 20,000 ft. so that he had to fly through the passes. "It wasn't crossing the Cordillera which most impressed me," he said. "I had expected even more. It was my return to Buenos Aires, at night. The town presented a magnificent spectacle. It is laid out like an immense draught-board. Narrow roads cut each other at right angles between the blocks of buildings. All were brilliantly lit. From above, these lamps gave the impression of a fabric of light. It was fairy-like."

On the other hand, early in the war of 1939, flying at night over blacked-out Toulouse, he had noticed that on clear nights all the details of the town were plainly distinguishable and that it would be easy to drop bombs on any desired target.

I believe it was the contrast presented by these two views of a town at night, the one lit up, the other blacked out, which gave birth to the idea of luminous camouflage. No seed was ever sown in vain in such a mind.

Black-out was poor camouflage for Toulouse. Buenos Aires on the other hand had been completely hidden under its carpet of light. Therefore it was surely better camouflage to light up a town than to black it out. But this would have been only a half solution. Although details were hidden, the target as a whole was clearly shown up.

Saint-Exupéry immediately conceived the idea that an excellent method of preventing a town or other target from being recognized at night would be to drown it in a large area of luminous points of great brilliance, evenly distributed. He had worked out his camouflage project down to the smallest details. The following is a brief outline of the principle and its application.

He had examined the two opposing ends of the problem, the perception of a light image in the eye and the optimum conditions for the emission of light to produce dazzling, namely intensity, distance and duration.

As is known, the contraction of the pupil varies with the degree of illumination of the most highly illumined point of the retina, but it has a definite limit. On the other hand the surface of the retina lit up by a source of light of sufficient density ceases to decrease after a certain distance. It therefore suffices to employ a source of light brilliant enough to ensure that no matter how great the distance the retina can no longer be protected by the iris, even when contracted to the maximum extent.

Saint-Exupéry had very carefully worked out how long the light had to persist to keep the eye dazzled. He based his calculations on two well-known but apparently paradoxical physiological principles.

For the same intensity, the retina is more greatly affected by a short burst of light than by a permanent light.

A light image persists on the retina only a fraction of a second. (The cinema has adopted the rate of 24 images per second.) Now, it has been demonstrated that the shortest excitations produce the most persistent images.

From these principles Saint-Exupéry had deduced that intermittent flashing lamps with sufficiently short intervals between the flashes should be used. Thus the eye, accommodating itself to flashes of bright light, would become incapable of distinguishing the shadows cast by buildings, woods, roads, lakes, rivers, in short any reflecting surface.

Thus to defend a territory from night raids by enemy air units it sufficed to equip the vulnerable areas with flashing lights of such density that whole towns or military targets became impossible to detect.

As regards the practical application of his principle, Saint-Exupéry had noted that the areas requiring protection were generally centres of dense population, where electrification was so advanced that the number of transformers available per square mile was approximately sufficient for the number of lamps necessary. He therefore suggested that the lamps should be installed on each transformer or in its immediate neighbourhood, thus reducing the costs of installation. The flash of each lamp was obtained by means of a periodic discharge of a condenser under alternating tension. This gives a great instantaneous brilliance and low power consumption.

Saint-Exupéry had discussed these lamps with the experts. They could easily be produced in large quantities.

He had gone a long way into the technical aspects of his project. He had even worked out costs. It would of course have been expensive but not prohibitive.

He then got into touch with the military committee on camouflage. The members of this committee showed considerable interest and asked for tests, which were carried out in the Toulouse (or Bordeaux ?) region. A first test was made with the material available, namely fixed lamps of medium intensity. The results were very encouraging. But the experiments were cut short by the German invasion.

*

To illustrate the diversity of his researches I shall give three examples of ideas of his which he did not follow up.

I do not know the exact date. It was in 1934, I think. We were talking about astronomy and he was telling me of the gaps in his knowledge. I mentioned to him the works of Eddington and Jeans. When I saw him again, a month later, he had already read the best works on astronomy and was full of enthusiasm for the subject. I suggested taking him to La Bouzaréah observatory. My friends, the Lagrulas, director and deputy director of the observatory, gave us a friendly reception. The conversation that followed throughout the night between Saint-Exupéry and the astronomers while they were observing the planets through the great telescope or waiting for a star to pass through the meridian, revealed to me the elasticity of his mind. He spoke to the experts on their own subject as an equal. On the way home in the car his fertile brain was already working out a telescope in which the optical system would be replaced by photo-electric cells. I do not know whether he ever pursued the idea.

Another idea occupied him for some time, during his enforced rest at my home, between August 1943 and March 1944, that of utilizing a ship's roll to propel it. He made a great many calculations on his usual thin paper. His hydrodynamic experiments with paper models in the bathroom surprised many of our visitors. Then one day he said to me : "You know, my idea is no good. You can only get a speed of five knots, which isn't enough."

On December 28th, 1938, he arrived at Algiers in the *Ville d'Oran*. During the voyage he had had leisure to observe seagulls in flight. What had struck him particularly was that when flying into the wind their propulsion was obtained by means of slow but efficient beatings of their wings. He had counted the number of beats and had naturally reached the conclusion, like so many others before him, that the air-screw represented a tremendous waste of energy. He had an idea. I don't know exactly what it was. He had already had it before this trip. He told me he had talked about it with several aeronautical engineers, none of whom appeared to be interested in any other form of propulsion than the propeller. "They refuse from the beginning," he said regretfully. He followed up his idea, however, since he asked one of my friends to shoot one or two seagulls for him so that he could study their wing structure. They were brought to him. I had to go to France while he was studying them, and the next time I saw him was in March 1939. By that time the threat of war occupied all our thoughts and we no longer talked about anything else.

*

Every inventor is first and foremost an observer. An invention begins in observation. Newton observed the fall of an apple and invented the law of gravity. Etymologically "to invent" means "to find." The pediment of Santa Croce in Florence commemorates the "invention" of the cross by Saint Helen. This invention was no more than a discovery. The full sense of the word is much broader however. To invent is to find new relationships between observed facts. But all

finding is preceded by observation. Saint-Exupéry was an indefatigable observer. There are many evidences of this in his writings. Whether he is describing noises, lights, the take-off of a flying boat in *Wind, Sand and Stars,* it is always with the utmost precision and a wealth of image.

The following example will show how closely, in his poetic transcription, observation approaches reality.

In *Flight to Arras* Saint-Exupéry describes an attack by anti-aircraft artillery he experienced when flying over the plain of Arras. Captain Israël (who had checked it himself) pointed out to me the meticulous exactitude of his description. It would be striking to the reader who could follow the physical conditions of the spectacle with his mind's eye.

The attack in question was by small calibre self-destroying shells with tracer charge. Saint-Exupéry, who was the conscious target, observed it in detail, while at the same time carrying out expert evasive action. His eyes swept in three directions, down towards the ground, horizontally and upwards towards the sky, and he notes with precision the various phases of the attack :

1) *The firing of the shells.* He watches the tracer shells coming up towards him : "The whole plain sparkles with short luminous threads." "We have been labouring heavily through the dark blue marsh already drowned in night. We have stirred up the tranquil mud and now it is sending up towards us thousands of golden bubbles."

2) *The rise of the projectiles towards the aircraft.* This happens at a very low apparent speed, "because there is no angular variation." The pilot looks down, the line of sight and the trajectory of the projectile coincide : the projectiles "at first look stationary to us, but then, like the juggler's balls, they slowly begin their ascent." "The rise of the bubbles in the immense blue aquarium."

3) *On the aircraft level,* when the pilot looks out horizontally, "a thousand elastic necklaces stretch out towards us, stretch until they burst and crack on our level." Because a number of guns dispersed over the plain are all concentrated on the one target, the angles of incidence vary and the shells which miss the aircraft seem to move away from it very fast. He describes the effect of their divergence : "I seem to be enveloped in a harvest of trajectories, the colour of stalks of corn." The aircraft is just about at the point where the stalks cross : "Here I am in the centre of a thick bunch of lances."

4) *The self-destroying projectiles burst* above the aircraft. The pilot raises his head : "As they went up, the tracers distributed these dark masses, one by one, like nails being planted." "I see them already massed into breathtaking pyramids drifting away rearwards, as slowly as an ice-pack," "monumental diadem with pitch-black jewels." "By comparison with such perspectives I have the sensation of being immobile." (And at this moment the aircraft is travelling at three hundred and thirty miles an hour.)

Saint-Exupéry does not fail to note the apparent silence of this gunfire : "This succession of dull explosions, the sound of which is covered by the growling of the engines, creates the illusion of an extraordinary silence."

He has forgotten nothing, he has seen everything, noted everything and he observed under conditions in which many an observer might well have lost his sang-froid.

Here is an extract from *Wind, Sand and Stars,* another page of penetrating observation. This time deduction is added to observation.

Saint-Exupéry is at a landing ground in the desert, preparing to pick up the mail for the North.

"... I hear a crackling, a dragon-fly bumps against my lamp. For no reason I am aware of, my heart goes cold.

I go out again and look : all is clear. A cliff bordering the airfield stands up against the sky as if it were daytime. A great silence, as of a house in order, reigns over the desert. But a green butterfly and two dragonflies come bumping against my lamp. And again I have this heavy feeling, which is perhaps joy, perhaps fear, but which comes from deep down inside me where it is still dark and obscure. Somebody speaks to me from a long way off. Is it instinct ? I go out again and the wind has dropped entirely. It is still cool. But I have received a warning. I divine, or imagine that I divine, what I am waiting for : am I right ? Neither the sky nor the sand have made me any sign, but two dragonflies have spoken to me, and a green butterfly.

I climb on to a sand dune and sit down facing the east. If I am right 'it' will not be long. What would they be doing here, the dragonflies, hundreds of miles away from the oases of the interior ? Bits of wreckage thrown up on the beach are the sign of a cyclone at sea. Thus these insects show me that a sandstorm is on the way ; a storm out of the east, which has despoiled the far-off palm groves of their green butterflies. The spray has already touched me. And solemn, because it is a proof ; solemn, because it is a heavy threat, and solemn, because it contains a tempest, the east wind rises. Scarcely does its faint sigh reach me. I am the furthermost limit licked by the wave. Twenty yards behind me not a sheet would have moved. Its heat has enveloped me once, with a caress seemingly dead. But I know, during the seconds that follow, that the Sahara is getting back its breath and is about to heave its second sigh. And that within ten minutes sand will fill the sky. Presently we shall take off in this fire, this return of the flames of the desert.

But this is not what moves me. — What fills me with barbaric joy is that I have understood a secret language from a half-word, have sensed elements like a primitive man, to whom all things to come are announced by faint murmurs, and have read the anger of the winds from the wing beats of a dragon-fly."

*

His ingenuity was constantly in evidence.

In New York, in his 21st-floor appartment at 240 Central Park South, he had experimented with little helicopters of light-weight paper, which he made himself and which, borne on the ascending air currents, whirled around outside his window a moment, and sometimes, instead of falling to the ground, were carried along by the breeze through the open window of a neighbouring appartment. These fragile little toys later amused the children of Naples or Algiers. And as they were not just toys, the Americans put the idea to practical use. They built helicopters to parachute containers.

I remember his enthusiasm the day he saw an Atmos clock at my home. This is a clock which a variation in temperature of one degree winds up for over four days and which therefore never runs down. He shouted with joy at the thought that it could go for three thousand years and that the rotation of the earth and the heat of the sun combined to operate it. It was the tangible manifestation in an appartment of a cosmic phenomenon. He wanted to buy himself one immediately. And later I did in fact see an Atmos clock in his flat in rue Michel-Ange.

The power of his intellect always led Antoine on from the particular to the general. His mind was boundless as the stars.

List of patents taken out by Antoine de Saint-Exupéry

No. 795,308 : *Device for aircraft landings.* Applied for December 15th, 1934. Published January 6th, 1936.

No. 836,790 : *New method of blind landing for aircraft, with practical equipment.* Applied for October 8th, 1937. Published October 25th, 1938.

No. 49,453 : *Addition* to previous patent. Applied for November 19th, 1937. Published January 17th, 1939.

No. 837,676 : *Goniograph.* Applied for October 29th, 1937. Published November 18th, 1938.

No. 838,687 : *Repeater system for indicators or measuring instruments.* Applied for November 29th, 1937. Published December 16th, 1938.

No. 850,093 : *System of lift and propulsion, principally for aircraft.* Applied for August 17th, 1938. Published September 4th, 1939.

No. 50,700 : *First addition* to previous patent. Applied for July 22nd, 1939. Published November 12th, 1940.

No. 50,809 : *Second addition* to patent 850,093. Applied for July 26th, 1939. Published January 9th, 1941.

No. 850,098 : *Route tracer, primarily for ships and aircraft.* Applied for August 18th 1938. Published September 4th, 1939.

No. 861,203 : *Improvement in method of checking engines in flight by means of a single indicator.* Applied for July 22nd, 1939. Published October 22nd, 1940.

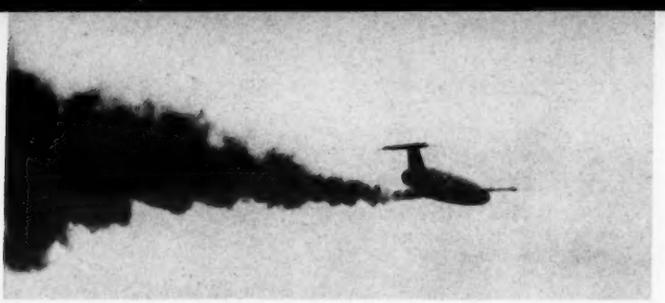
No. 861,386 : *New device for starting engines, particularly for aircraft engines.* Applied for July 28th, 1939. Published October 28th, 1940.

No. 870,607 : *New method of measurement by the superposition of symmetrical curves, and application to D/F indicators.* Applied for June 24th, 1939. Published December 22nd, 1941.

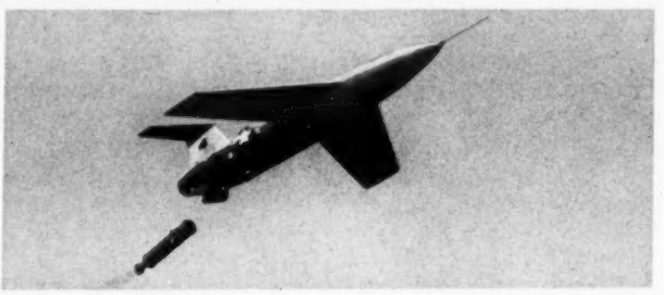
No. 924,902 : *New method of direction finding by electromagnetic waves.* Applied for February 19th and 29th, 1940. Issued March 17th, 1947. Published August 20th, 1947.

First of the Fantastic

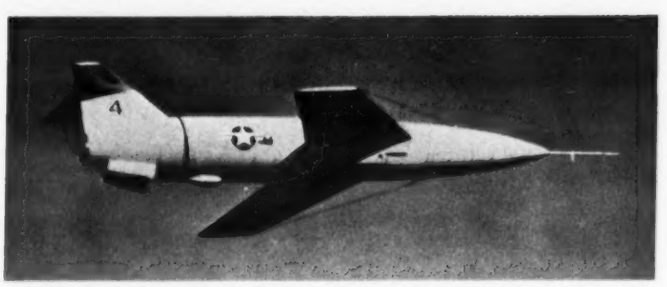
On October 1st the U.S. Air Force activated the *First Pilotless Bomber Squadron (Light)* at the USAF Missile Test Centre, Cocoa, Florida. The squadron is the first operational unit of its kind in the USAF. Initially it has been equipped with the B-61 "Matador" pilotless jet bomber, now in production by the Glenn L. Martin Co. at Baltimore, Md. The squadron is supervised in its early training by an established training unit, the 6555th Guided Missile Wing, a part of USAF's Research and Development Command. Later it will be made combat-ready by extensive unit training under the supervision of Tactical Air Command.—This is the gist of a USAF announcement of a few weeks ago.



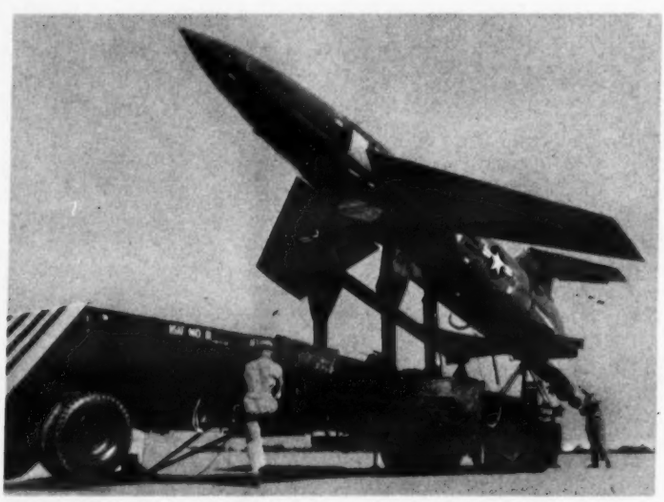
The booster rocket is about to drop off, its thrust expended. The "Matador" is tracked by radar stations established along its way, telemetering information back to base to supplement data emitted by the bomber itself. Maximum length of the Cocoa over-water range is 600 miles.



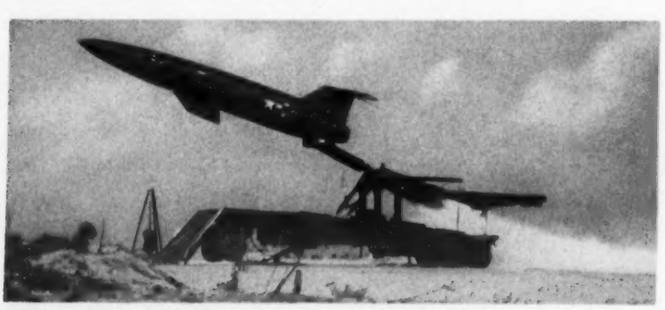
The booster rocket drops away.



The "Matador" wings its way to the target under its own power.



The Martin B-61 "Matador" radio-guided tactical bomber being readied on its mobile ramp at Cocoa, Florida. The machine is much larger and faster than the wartime German V-1 expendable "buzz-bomb."



With a roar from its single turbine engine and the auxiliary booster rocket under the tail the "Matador" takes off.

Still helped along by its booster rocket, the "Matador" gains height and speed. The first flights at Holloman Air Force Base, New Mexico, were somewhat restricted, as the "Matador" had to be flown in "figure eights" and circles to stay within the range, but at Cocoa the swift bomber flies straight out over the Atlantic Ocean.

The pictures on this page give an idea of what the "Matador" looks like and how it operates. The aircraft strongly resembles the Martin B-51 three-engined piloted tactical bomber but has only one jet engine and a booster rocket for initial acceleration. It is not disclosed whether the aircraft is "expendable" or not—i. e., whether it is radio-guided to its target and dives on to it, or whether it will report its exact position, speed, height and course back to the operator, enabling him to release bombs at the right moment, and to guide the aircraft back to base. That the "Matador" is to be used tactically is implied by the fact that operating squadrons will be placed under USAF's Tactical Air Command.

There is a possibility that the new aircraft will carry tactical atomic bombs or an atomic warhead—such weapons are known to have been under development for some time. Air Force Secretary Thomas K. Finletter himself recently called for air strength capable of "bringing atomic power to bear directly on the enemy's ground forces," and Representative George H. Mahon, Chairman of the Appropriations Sub-Committee of the House Armed Services Committee, said a few weeks ago that the USA will spend $1,000,000,000 before next July on guided missiles, some of them carrying atomic warheads. "We are moving toward the use of atomic artillery," he added.

Some sources claim that a long-range radio-guided bomber is now being developed in the USA. President Truman merely confirmed at a press conference in the middle of September that the "Matador" is one of the new weapons, "*fantastic in their operation,*" to which he had referred in a speech at San Francisco ten days earlier.

IATA Mixes with the People

Airline delegates attending the *Seventh Annual General Meeting* of the *International Air Transport Association* in London from September 10th to 15th listened to the annual report by the Association's Director-General, reviewed the work done during the year by the specialized Sub-Committees, each of which had submitted a report, spent a day at the Farnborough SBAC Display and several evenings at banquets, and made their routine annual elections. On the first day, Sir Miles Thomas, BOAC Chairman, took office as 1951-52 President of IATA in succession to TWA Chairman Warren Lee Pierson.

In his report, Sir William P. Hildred, Director-General, announced that the IATA airlines had flown 30,000,000 passengers in 1950, 15 percent more than in 1949, and travelled a total of 26,000,000,000 *passenger-kilometres*. *Cargo ton-kilometres* increased 33 percent from 1949 to 759,000,000 in 1950. The airlines provided 210,000,000 *ton-kilometres of mail* transport during 1950, a 12-percent increase. The number of aircraft in the *airlines' fleet remains about 2,500*, but their higher speeds and larger payloads now provide 40 percent more passenger and cargo capacity than they did four years ago. *Gross revenues* of the airlines during 1950 were approximately $1,500,000,000. Finally, preliminary statistics for 1950 indicate that the safety record had further improved.

In the financial field, Sir William said, substantial economies had been achieved by standardizing interline accounting. IATA technical experts had submitted a plan to ICAO to relieve the increasing congestion of air traffic over Europe and the Mediterranean. The IATA Traffic Conferences had experimented "rather boldly" in the absence of any precedents for the world-wide pattern existing today. Facilitation of air transport by cutting customs and other red tape had progressed during the past year, but more cooperation from the airlines themselves and by governments was necessary.

Alluding to proposals for cheap tourist rates, Sir William welcomed efforts in this direction, adding that the introduction of cheap travel would "clean up the competitive picture." Some of the airlines were preoccupied with the share of the market taken by the other airlines, to the exclusion of the mass market in their reach.

*

The Director-General thus arrived at the subject which dominated the entire Meeting. In fact, delegates bent over backwards—figuratively—to prove that their dearest wish is to implement their Bermuda decision of May 1951 to open second-class or "coach travel" services as soon as possible, in order to make the advantages of air transportation available to every man with a middle-class pocket-book *.

It was Prime Minister Clement R. Attlee himself who hinted at the meeting's *mot d'ordre* in his address before the inaugural session, when he said : "Civil aviation today has taken its place as one of the normal means of transport, *at least for those who can afford it . . .*"

The theme was taken up by the 1951-52 President of IATA, Sir Miles Thomas, Chairman of BOAC, as well as by Sir William Hildred, IATA Director-General. Their statements effectively highlighted the IATA announcement in Bermuda that North Atlantic tourist air services would begin in October, 1952.

Sir Miles Thomas forecast that ". . . international air transport will soon be made available to a very much larger number of people in the middle income groups. It is important not only for its own proper development *but from the point of view of its social responsibilities* that travel by air shall be made available not only to the favoured few, but to every citizen of the world. IATA is already considering tourist-rate services across the North Atlantic and elsewhere . . . If we proceed sanely, soberly and energetically our difficulties can all be overcome and we can offer the advantages of air travel to millions of new customers . . ." In his report *Sir William Hildred* went on to stress the "desire of the average man in every country to travel far and wide on his vacation" and underlined the importance of introducing "nothing short of a complete all-year-round, regular two-fare system." He hailed the airlines' decision to begin cheap services across the Atlantic in October, 1952—which, curiously enough, coincides with the *end* of next year's vacation season . . .

The airlines' sudden awareness of their social responsibilities is touching. It makes us think of the cat who had been feeding on cream for years ; one day it overtuned the milk pot, lapped up the milk, and felt fat and happy in the thought that it was supporting the dairy industry. And here we have the airlines, who so far have carried the cream of international passenger transportation, falling over each other trying to show how much they would like to get the world's little men aboard their aircraft—not, mind you, because they want to open up the huge untapped mass market of middle-class humanity for their own benefit, but to give the little man a good time . . .

"Needs must when the devil drives . . ." Air coach services have rarely been introduced voluntarily by the regular airlines. In the USA they became a necessity several years ago because a large number of American post-war "wildcat" operators were muscling in on the regular air transport business with astoundingly cheap fares. The cheapness of these fares was easily explained—war surplus flying equipment bought far below first cost, absence of regular schedules, lack of elaborate ground organization, etc. But the U.S. regular airlines had seen the

The Seventh Annual General Meeting of the International Air Transport Association was held in the historic Great Hall of Westminster School, London, in September.

* Cf. also "INTERAVIA, Review of World Aviation," No. 9, 1951 : "Bringing Air Travel to the Man in the Street" ; do. : "Outlook for Air Transportation," by Henri Ziegler, Managing Director of Air France.

danger signal and began to introduce reasonable "coach fares" all over the country. They did not lose by it, but the devil had really been driving.

On the whole, the air transport industry has made itself a reputation for its advanced ideas and practical approach to new problems, and there is no doubt that a few of the airlines are seriously studying the possibility of opening coach services without much delay. Foremost among these is Pan American World Airways, followed by Air France, both of whom already operate tourist services on some routes. In their 1950 annual reports even BOAC and BEA advocate the introduction of utility services. Why, therefore, must the opening of coach services be delayed again, for another year on the North Atlantic, probably much more on the other routes flown by European operators ?

The reason is, partly, that most European airlines are not equipped to open such services at the present time, and partly that they are afraid that some of their present luxury clientèle will transfer to the coach lines. Their air fleet is fairly busy carrying the "cream" traffic, and naturally they are disinclined to divert part of it to cheaper uses. Thus, under IATA's tight control, even those airlines which *have* the means of pioneering mass air travel must wait until the laggards are mentally and materially ready—or until the "cream" is in short supply . . .

All the IATA airlines agreed to in London was a "controlled experiment" in mass air transportation from October 1952 onwards on the Atlantic and (at the instigation of South African Airways) between London and South Africa. North Atlantic and U.K.-South Africa operators will place their detailed experience at the disposal of other IATA members to determine whether these tourist services can be applied to other world routes—probably only in several years' time.

At the close of the IATA meeting in London representatives of the eleven North Atlantic scheduled airlines sat down together supposedly to determine exact fares and exact dates of introduction of the tourist services across the North Atlantic. The representatives emerged on September 21st to announce meekly that their "intention to inaugurate such services in October of that year remained unaltered." But they had found that it would not be possible to bring the programme into effect by means of a mail vote of the IATA members involved and had therefore referred the matter to a meeting of IATA Traffic Conferences 1 and 2 to be held in November. A perfectly non-committal statement. Everybody had agreed to pass the buck to the Traffic Conferences. Everbody ?

Not everybody. Willis G. Lipscomb, Vice-President (Traffic and Sales) for Pan American World Airways, issued his own, much more revealing, statement the same evening, September 21st. He declared that PAA intended to inaugurate a low-fare tourist-class service across the North Atlantic *in the summer of 1952 on the basis of a fare of $250 or less* between New York and London, notwithstanding the fact that the other North Atlantic carriers had turned down this proposal. He stated bitterly : "Once again it seems that Pan American has been denied approval of its long-sought objective of introducing tourist services on the North Atlantic..."

Not everybody agreed with the decisions of the North Atlantic airlines' representatives announced after a special subcommittee session following the General Meeting. PAA's Willis G. Lipscomb (left) in fact disagreed thoroughly.

"Since 1948 we have been fighting for approval within IATA of our programme. We have just concluded here today a two-day meeting with other North Atlantic carriers. The purpose of the meeting was to specify a precise fare for the tourist service to begin next year across the North Atlantic.

"This purpose was defeated. Pan American thereupon announced to the meeting that it intended—either within the framework of IATA, or outside that framework if necessary—to obtain governmental approval to introduce tourist services across the North Atlantic in 1952 at a fare level that will appeal to the general public."

Lipscomb recalled that at the IATA traffic meeting in Bermuda last May the airlines agreed to introduce a tourist-class service in the fall of 1952, leaving a subcommittee to work out certain points, including the precise fare between a minimum of $225 and a maximum of $250 one way between London and New York.

"Notwithstanding this firm commitment, the agreement has been repudiated at the London meeting," Lipscomb said.

He added : "It is an interesting point that opposition to the proposal was led by certain airlines which have been most vocal since the Bermuda meeting in stressing the virtues of tourist-fares."

In reply to a question whether these low fares might not prevent the company from obtaining landing rights in some European countries, Lipscomb added : "I am confident of our ability to obtain permission to run tourist services between the United States and some country on the Continent of Europe . . ." Since most European national airlines are in the camp opposing PAA, the name of that country seems easy to guess : a country *without* a national airline as yet, in other words, Germany, where PAA already has landing rights.

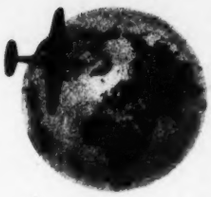
"Needs must when the devil drives." A few years ago PAA was itself one of the "driven." That was when irregular operators forced it to introduce low fares on the heavily travelled New York—Puerto Rico route. Today Pan American is doing the driving over the North Atlantic—and in its attitude it is backed by the U.S. Civil Aeronautics Board which had previously expressed dissatisfaction with the limitations imposed upon the tourist proposal adopted by IATA at Bermuda.

Nobody hates a price war more than the airline industry, and PAA's stand will hardly be permitted to cause such a war, as some have predicted. But PAA's insistence on an early introduction of *really* cheap tourist services can be regarded as a guarantee that such services will be adopted in the near future by all, or virtually all, the airlines concerned.

*

At the final plenary session of its Seventh Annual General Meeting, IATA unanimously nominated its President for 1952-53. The President-Elect is *Dr. Walther Berchtold*, Managing Director of Swissair, who will take office at the opening of the Eighth Annual General Meeting. In accordance with tradition this meeting will be held in Switzerland in the autumn of next year.

Four IATA Presidents : Dr. Walther Berchtold, Swissair's Managing Director (centre), is President-Elect for 1952-53. The others are, reading from *right to left :* Sabena President Gilbert Périer, 1948-49 IATA President ; BOAC Chairman Sir Miles Thomas, 1951-52 President ; TWA Chairman Warren Lee Pierson, 1950-51 President ; Sir William Hildred, IATA Director-General. Not shown is Dr. Albert Plesman, President of KLM Royal Dutch Airlines, who presided at IATA's 30th Anniversary Meeting at the Hague in 1949.



What's in the Air ? *

PERMANENT AIR FORCE EXERCISES

Nowadays pilots scarcely have time to get out of their machines, there are so many air exercises all over the world. *Air forces* of the *Atlantic Powers* have already held two major exercises during the summer of 1951—"*Exercise Ombrelle*" to test the preparedness of the Western European ground organization, and "*Exercise Velox*" a joint exercise with the Atlantic naval forces in the protection of a convoy in the Channel and the North Sea. On September 28th they started on "*Exercise Cirrus,*" the largest exercise held since the war. Units from seven countries (USA, Britain, Norway, Denmark, Holland, Belgium, France) took part, under the command of Lieut.-General Lauris Norstad, Commander-in-Chief, Allied Air Forces, Central Europe. Object of the operations was to ward off an air offensive carried out by the most up-to-date means against Western Europe, including Western Germany.

At the same time (September 29th to October 7th) the RAF organized a general test for Great Britain's air defences, known as "*Exercise Pinnacle,*" in which the attacking bomber units were commanded by a Briton and an American. A point of special interest is that this exercise dealt for the first time with the problem of "civil air traffic under war conditions."

*

Meanwhile, the *Red Air Force* has been carrying out similar exercises over the Eastern zone of Germany. The object of the manoeuvres held in Brandenburg at the end of August was an attack on Berlin by Tupolev Tu-10 twin-engined light bombers (altitude of flight 800 ft.), while ground attack operations by Ilyushin Il-10 single-engined tactical bombers were taking place near Döberitz training area.

September 13th marked the beginning of the full-scale autumn manoeuvres of all the Russian forces stationed in Germany, under the command of General Chukov. These exercises, held in Western Saxony (Zwickau), also laid special stress on ground attack missions. The jet fighters used were doubtless MiG-15s, large numbers of which have recently been moved to Eastern Germany.

In this connection there has been a press report that a MiG-19 jet fighter, derived from the MiG-15, has started flight tests (speed given as over 620 m.p.h.). Our picture—which should be regarded with reserve—shows the most notable feature to be the short, egg-shaped fuselage. No details are known of the jet engine.

*

A difficult position at the moment is that occupied by the States outside the great coalitions, whose neutrality in the event of war would depend on the good pleasure of the belligerents. Militarily and financially speaking, they have to bear the load of preparations on two fronts. The Swedish Air Force, for example, held exercises in both East and West of the country, during September. In the West the main emphasis was on the testing of defences, the fighters being controlled from underground command posts. The Baltic exercises involved approximately 20,000 men from the Air Force and the Navy, 300 first-line aircraft from 15 different squadrons, 100 naval craft and the fixed coastal artillery. Radar control of air and naval units was the centre of attention here.

Seeing that over 75,000 men were engaged in the ground exercises which were held at the same time, it is easy to understand why the Swedish defence estimates for 1952-53 exceed last year's by a full 29%. The Commander-in-Chief of the Swedish forces has mentioned S.Kr. 1,520,000,000 (S.Kr. 340,000,000 more than for the 1951-52 fiscal year) and put the funds for the procurement of equipment at a total of S.Kr. 1,143,000,000 (including S.Kr. 390,000,000 for aircraft and equipment ; S.Kr. 491,000,000 for naval craft and artillery ; S.Kr. 262,000,000 for Army equipment).

*

Let us close this chapter on air defence with the remark that the special Air Force credit for "secret projects" overseas ($1,071,000,000) applied for from the U.S. Congress is largely intended for the construction of radar installations in Europe, North Africa and the Mediterranean area.

Group Captain E. C. Luke, Chief Logistics Planner, Royal Canadian Air Force, has been posted to the *staff of General Lauris Norstad, Commander-in-Chief of the Allied Air Forces, Central Europe* (headquarters at Fontainebleau).

C. T. Zaoral, general manager of Bendix International Division (New York), has joined the *board of directors of Bendix-Tecnico Proprietary Limited,* a newly-formed Australian affiliate for the production and distribution of Bendix aviation accessories.

AMAZING TURNOVER IN THE AIRCRAFT INDUSTRY

Anyone seeking information on prospects in the aviation industry need only look at the efforts made by the various firms to keep their workers in a good humour and thus hold them at work. For example *North American Aviation Inc.* offers their personnel a full-scale football league, a rifle and pistol club, a "family chorus," a golf league, baseball league, hobby club, etc.

The scarcity of skilled workers is by no means limited to the U.S. For several months past the Swedish aviation industry at Trollhättan has been engaging foreign staff. The *Svenska Flygmotor AB,* Sweden's aircraft engine producers, took on a first batch of 50 skilled workers from Western Germany during September ; others are to follow later in the autumn. The Svenska Aeroplan AB *(SAAB),* which supplies Swedish jet fighters, has for some months been employing personnel from Northern Italy. In October a first group of 100 German mechanics is expected. SAAB works engineers at present in Germany are arranging to take on more.

*

This picture is completed by the orders received, profits made and plant extension undertaken.

Lockheed Aircraft Corp. admittedly reports a net profit of only $4,047,476 for the first half of 1951, compared with $4,391,358 for the similar period of last year ($3.58 per share instead of $4.01). But receipts increased during the same period from $84,922,968 to $101,339,650—a sign that extensive investment is in progress. The President, Robert E. Gross, has described these six months as a "make-ready" period, and the rapid increase in the backlog of orders by no less than 350% fully confirms these words (since June 30th, 1951, the backlog has grown still further, from $793,438,000 to $1,245,600,000).

No wonder that Lockheed is to invest $12,615,000 in the construction of a new jet fighter plant at Palmdale. Considerable expansion is forecast for this small town on the edge of the Mojave desert, 65 miles north-east

A historic moment for the helicopter : Using 21 ten/twelve seater Sikorsky S-55 helicopters, 300 American Marines landed on a hilltop in Korea with eight tons of equipment.

* Extracts from *Interavia Air Letter,* daily international news digest, in English and French. All rights reserved.

Prototype of the Bristol 173 twin-engined commercial helicopter being prepared for its first flight.

of Los Angeles. The U.S. Air Force plans to build its largest test and production centre of jet aircraft here. Three factories, costing altogether $36,000,000 to erect, are to be run by Lockheed, North American and Northrop. It goes without saying that the days of civil aviation at Palmdale Airport, which belongs to the city of Los Angeles, are numbered. The "jet fighter desert" may have neither eyes nor ears.

Elsewhere, too, firms are building and purchasing feverishly. *The Glenn L. Martin Co.* is to enlarge its production space by 1,550,000 sq.ft. and its storage area by over 220,000 sq.ft. The *McDonnell Aircraft Corp.* proposes to buy the plant it has hitherto leased from the city of St. Louis ; price : $9,873,093, which will give the firm not only the present plant area of 48 acres but also an additional 33 acres and the option to buy a further 28.7 acres. *Northrop* is showing lively interest in ram-jet propulsion and is planning to erect a smaller experimental centre next to the USAF's guided missile base at Cocoa, Florida. *Pratt & Whitney Aircraft Division*—the engine division of United Aircraft Corp.—although already building extensive new plant, has leased a tool and machinery stores at Waterbury, Conn., to relieve the fully-occupied plants at East Hartford, Southington and North Haven.

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Britain too is not far behind. For example, the *Hawker Siddeley Group* has set up a new subsidiary, *Brockworth Engineering, Ltd.*, to speed up production of the well-known Armstrong Siddeley "Sapphire" jets. Including this firm there are now at least five works engaged on the production of the "Sapphire" ; in Britain the Coventry works of Armstrong Siddeley (for the RAF) ; in the U.S. (under licence) Curtiss-Wright and the Buick and Syracuse plants of General Motors (for the USAF).

And from *France* there came in mid-September the surprising news that the U.S. has decided to build French light engines under licence. *Continental Motors Corp.* has acquired licences from *Société Turboméca* of Bordes for the construction of the latter's "Palas," "Marboré" and "Aspin" jet engines, "Artouste" gas turbine and "Palouste" generator. The *Stratos Division of Fairchild* has also been given a licence for the "Orédon" gas turbine. According to C. J. Beese, President of General Motors, these power plants are intended primarily for installation in military machines, such as guided missiles, helicopters, target and liaison aircraft, but will also be used for civilian purposes. Licence negotiations are also in progress with the British firm of Blackburn and General Aircraft Ltd.

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An interesting point is that these boom conditions in the aviation industry are affecting the most unexpected branches of production. For example the Speidel Corp., one of America's biggest jewelry manufacturers, has received an order from the USAF for precision instruments. Security regulations have made it impossible for further details to be published. Nevertheless it is known that several million dollars are involved.

EUROPEAN AIR TRANSPORT UP TO DATE

Reference has repeatedly been made in *Interavia* to the absence of any *group advertising in European air transport*—the type of group advertising which has become a recognized feature of American air transportation. There is of course still no European air transport association which could sponsor "anonymous" advertising, like the American ATA does. Nevertheless a first group advertisement has recently appeared in one of the leading Swiss daily newspapers (Neue Zürcher Zeitung) publicizing reduced return fares between Europe and the U.S. and signed by five leading European airlines, Swissair, KLM, SAS, BOAC and Air France.

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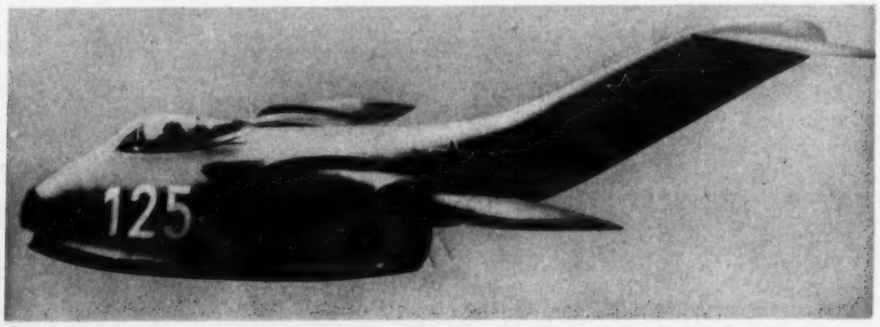
So much for "all-European" air transport. What is happening in the individual companies ? *British European Airways*, which recently opened regular helicopter services on several domestic routes, has announced another innovation, the use of new propeller turbine aircraft for freight transport. On September 6th a Douglas "Dakota" fitted with two Rolls-Royce "Dart" propeller turbines on September 6th opened the London—Brussels sector (flying time 1 hr. 20 mins.) of a regular London—Brussels—Bückeburg (Germany) freight service.

Air France, which reported considerable traffic increases during the first four months of 1951 compared with the corresponding period of last year (passengers 21% ; freight 29% ; mail 17% ; parcels 57%), is expecting the delivery of four Lockheed L-749 "Constellations" in October, with which it is to modernize its South American services.

In other words... European air transport has not lost its drive... except perhaps the *Portuguese Ministry of Transport*, where a certain *"aviation fatigue"* appears to have set in. The *Transportes Aereos Portugueses (TAP)* established after World War II and operated by the Portuguese Government was put up for sale to the highest bidder in September, a unique event which aroused considerable interest in aviation circles. Conditions seemed attractive : a twenty-year monopoly on the routes from Lisbon to West & East Africa, Rio de Janeiro, Madrid, Paris, London ; if necessary a government subsidy ; duty-free importation of fuel ; exemption from taxation. The purchaser must employ Portuguese personnel. In the event of war the company can be requisitioned. Preference will be given to the group proposing to organize the most complete domestic network. So far offers have been received from a wealthy Portuguese group which already runs *Aeroportuguesa*, a British charter company and two French private enterprises.



MiG-19 ? This picture of a swept-wing fighter, which is said to be the latest model by the Russian designers Mikoyan and Gurevitch—MiG-19—recently appeared in the daily press.

De Havilland D.H.110 two-seater fighter with two Rolls-Royce "Avon" jet engines of 6500 lbs. static thrust each.

German Radiolocation in Retrospect (II)

The Anti-Aircraft Artillery's Radar Equipment

by A. E. HOFFMANN-HEYDEN

In No. 6/1950 we published an article on the development of radiolocation in Germany by Dipl. Ing. L. Brandt, who today plays a leading part in German transport affairs. Judging by the correspondence received, this article aroused general interest.

The following paper supplements Brandt's article and deals with a sphere for which he, as research chief at Telefunken G.m.b.H. was also responsible, namely the radar instruments used by the German anti-aircraft artillery, in particular the "Egerland" unit which operated in the 9 cm band.

The author is A. E. Hoffmann-Heyden, former head of the military test group for A/A radar (FAS III) of the Luftwaffe.

Editors.

In the early days of the Luftwaffe's Schwere Flak (heavy anti-aircraft artillery) targets were located only by *optical* range-finders, and firing was controlled by mechanical gun directors, called Kommandogeräte[1]. Values for distance, azimuth and elevation were fed continuously into the latter, and the appropriate angles of "lead" calculated. The gun predictors then transmitted the final setting values for gun-laying and shell fuse timing to the guns.

However, dependence on visual sighting of the target (in cloudy or foggy weather the anti-aircraft artillery was virtually blind) and the inadequacy of acoustic detection early led to plans for a method of detection which would be independent of weather and time of day. So as to allow for the fact that the enemy's speeds and heights of flight would undoubtedly increase, the range of this non-visual detector had to be double the maximum range of the guns, so as to give ample time for the gun director to operate.

The German Army Ordnance Office (Heeres-Waffenamt) entrusted with the development of this plan turned its attention to instruments to measure *electrical reflections* working on the pulse principle, and to *infra-red instruments*. The second system was chosen because there was no means by which the crew of the target aircraft could detect its use.

The following values were aimed at for anti-aircraft radiolocation instruments:— uninterrupted observation of the target with mean angle errors of less than ± 1/16 degrees, distance measurement accurate to within ± 10 m, range during search 50 km, during precision measuring 25 km, suitability for use as short-range aircraft reporting apparatus in support of the air observer posts. Finally there was a long-term plan to make the search and measuring processes automatic, so as to eliminate human errors.

This shows that the A/A artillery, which did not yet have proximity fuses and target-seeking projectiles, of necessity had to make very heavy demands on its radiolocation equipment. The table of instrument types (p. 627) shows how these values were gradually approached.

The first anti-aircraft radar apparatus.

Preliminary work by C. Lorenz AG. led to the production in 1938/39 of an instrument which was later used under the designation of *Fu.M.G.39L* (62 cm., 2 kW) and *Fu.M.G. 40L* (53 cm., 50 kW)—and which had what was then a very high accuracy in distance measurement (Fig. 1). Pending the development of a suitable simultaneous apparatus the transmitter and receiver aerials were arranged in two reflectors, 2-4 m in diameter, one above the other. As the apparatus (Fu.M.G.39L) did not permit bearings in azimuth and elevation to be taken, but could only follow the target roughly by determining the echo maximum, it could only be used as an early warning apparatus and for distance measuring. To obtain bearings a supplementary infra-red instrument was planned, but was never used, as its range was too small.

It was not until the summer of 1940 that the A/A radar service really took a step forward through the introduction of the "Wurzburg" or *Fu.M.G.39T "A"* apparatus. It had a wavelength of 53 cm., a power of 8 kW and a reflector 3 m. in diameter. It could be used both for short-range scanning and for obtaining fire control values. It had a range of 30 km and a relatively sharp beam. On the other hand it could not provide satisfactory azimuth and elevation values. However, this shortcoming was overcome by graphic plotting systems to such an extent that adequate initial values for the *Kommandogerät* could be produced.[2]

At first A/A radar instruments were only few in number. Therefore *conversion systems*

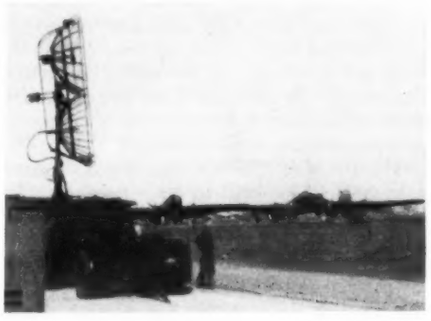
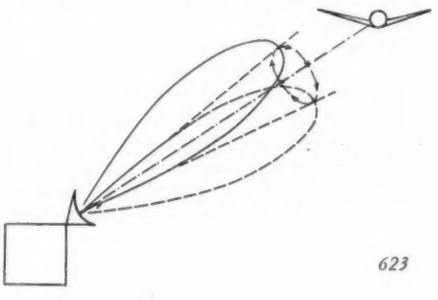


Fig. 1 : The Fu.M.G. 40L search radar developed by C. Lorenz AG. (53 cm wave length; 50 kW) still had separate reflectors (each 2.4 m in diameter) for transmission and reception.

were introduced whereby gun directors belonging to neighbouring batteries and searchlights, were supplied with distance, azimuth and elevation values converted to suit their own position. The information provided by the radar apparatus was particularly valuable to the searchlights, which could thus find their targets much more quickly than had been possible with the old sound detectors.

Later in 1940 the "Würzburg" was fitted with a *defocussed rotating dipole* ("Grille") for beam D/F (Diagram 1). This made it possible to supply the gun directors with continuous azimuth and elevation data. This

Diagram 1 : Principle of beam D/F : By means of the rotating dipole arranged eccentrically to the axis of the reflectors, the diagram of emission turns around the surface of a cone. The echo of a target which is not exactly in the axis of the reflector is therefore modulated with the frequency of rotation, its sound intensity depending direct on the error.



[1] The gun directors in use were the *Kommandogerät 36*, with a laying accuracy of ± 0.6/16 degrees for azimuth and ±0.5/16 degrees for elevation and the *Kommandogerät 40*, with ± 0.4/16 degrees (azimuth) and ± 0.1/16 degrees (elevation).

[2] The position of the target was plotted at regular time intervals by maximum intensity D/F, and its track drawn in the map. In this way it was possible to measure the speed of the aircraft. The latter then served as basis for calculating the course and the changes in position during the intervals between the individual plots, so that more or less continuous values could be fed to the gun directors.

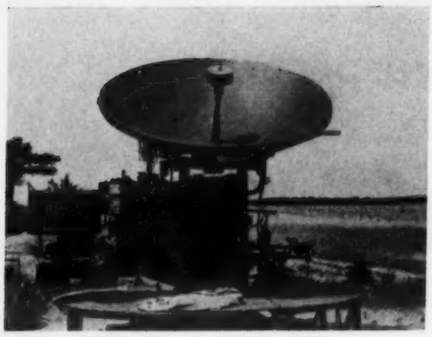


Fig. 2: Developed by Telefunken GmbH, the Fu.M.G. 39T "C", "Würzburg" with defocussed rotating dipole (53 cm; 8 kW) soon became standard equipment for the German heavy A/A units.

step was of the utmost importance, as was clearly reflected in the A/A defence successes at that time. True, the new equipment's azimuth and elevation accuracy of $\pm \frac{1}{2}°$ and distance accuracy of approx. ± 100 m. were still nowhere near the values originally demanded. On the other hand the still more substantial errors so frequently arising during graphic plotting were eliminated.

This *Fu.M.G.39T "C"* (fig. 2) was the first apparatus to be built in large numbers. It was supplied to the A/A artillery with top priority. All earlier models were converted to the new beam D/F system or exchanged. By the end of 1941 there was scarcely a radar apparatus in use by the A/A units without beam D/F.

To increase the accuracy of range measurements and to provide a method of automatically transmitting values to the gun directors, Telefunken produced the "*Emil*" auxiliary apparatus in 1941. Like the beam accessory, it could be integrated into the "Würzburg". The "Emil" gave a distance accuracy of ± 30-40 m. The distance values were either read off from a scale (instead of the scope) or transmitted straight to the director by means of an electric transmission system. This accessory too was gradually added to all the older radar apparatus. The new type was known as the *Fu.M.G.39T "D"*.

Special anti-aircraft radar.

Parallel to the introduction and development of the "Würzburg" the Army Ordnance Office had placed orders for the production of special anti-aircraft radar to achieve, regardless of expense, the accuracy required for the gun directors.

Telefunken first produced a small series of type *Fu.M.G.40T*, known as the "*Mainz*" for experimental purposes. Its successor, the *Fu.M.G.41T "Mannheim"* (fig. 3), differed in essentials only externally, but went a good bit further than the "Würzburg" towards filling the precision requirements of the A/A artillery. Electronically it was about three times more complicated than the "Würzburg", but was of particularly robust and mechanically accurate construction. It was the most efficient mobile radar unit available at that time to the A/A Artillery.

The wavelength of 53 m. and 3 m. reflectors were retained. Beam concentration was not so sharp as to make search for the target difficult. On the other hand the use of instruments for distance, azimuth and elevation gave double the accuracy of the "Würzburg" and greater constancy of measuring values. The latter was favoured by the fact that the mechanical laying drive was operated by "speed-controlled" gears.[3] Compared with the light construction of the "Würzburg" the mechanical structure was much more rigid and corresponded in the precision of its gear mechanism to the gun directors and guns.

The operating personnel were accommodated in a closed cabin, so that they could concentrate undisturbed on accurate measurements. At one side there was a control stand from which the squad leader could supervise the work of the crew with the aid of cathode-ray tubes and could turn the reflector in the direction of the determined or supposed target by overriding the operation of the laying equipment. In addition to its instrument indicators the "Mannheim" also had the same cathode-ray tubes as the "Würzburg D", an arrangement which was found to be extremely valuable when enemy jamming began later. All the values obtained, including the target height and map distance calculated automatically in the apparatus were transmitted by electrical systems to the predictors, so that errors or delay in readings were eliminated.

[3] Whereas normal hand gears transmit each movement direct (so that any irregularities will also immediately affect the movement of the reflector), with the speed-controlled gear a first derivative of the movement (i.e. speed) is automatically added to the hand movement. This results in smoother movement of the reflector. Speed-controlled gears were also selected because otherwise the constant handling of the heavy weights of the Fu.M.G.41T was a definite physical strain which would have reduced the crew's powers of concentration.

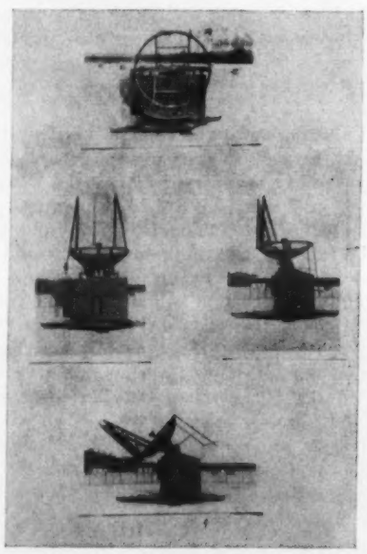


Fig. 3: The Fu.M.G. 41T "Mannheim" A/A fire control apparatus (53 cm wavelength; 3 m reflector) with "lip" to eliminate distortion of elevation measurements due to ground reflections.

The considerably greater electrical and mechanical cost of the "Mannheim" naturally handicapped its production. This equipment, as a rule, was therefore used only at key points in the defence system, where more than four guns per battery were grouped together to form a firing unit. Although it represented in every respect a great advance, it never achieved any really outstanding success. It was found later that it was much more difficult to incorporate the anti-jamming accessories into its complicated technical structure than into the "Würzburg".

Some of the fixed anti-aircraft batteries (on towers) were also provided with "Würzburg Giants" (Fu.M.G.65) with large reflectors (7.5 m in diameter) and a mechanical precision equal to that of the "Mannheim". They had virtually the same D/F accuracy as the "Mannheim" and about double the range. The electrical equipment and the measuring unit of the "Würzburg Giant" were similar to those in the "Würzburg D".

The "Würzburg D" and the "Mannheim" introduced in 1942 became more or less standard equipment for the A/A Artillery. That this policy of standardisation was the correct one was proved in the years that followed. Plans were made for improving the apparatus and for protecting them from air attack, and a new model of the "Mannheim" (the "Mannheim K") to operate on a wavelength of 25 cm. was planned.

The turning point

In the spring of 1942 the frequency-setting parts of a "Würzburg A" fell into British hands and the danger of active interference with the A/A radar equipment by the use of jamming transmitters suddenly came very close. The only effective counter-measure was to change the frequency of the radar units. Although such an operation ("Wismar") was rendered somewhat difficult by the fact that the parts were designed for a constant frequency with very little scope for variation, it was not long before radar instruments could be operated on various fixed frequencies around the original value. This was an emergency measure only and later a system of constantly changing frequencies was introduced, with at first a variation range of ± 6-8 mc/s. A broadband development begun at the same time by Telefunken (with new dipoles, transmitter and receiver-tuning parts) finally provided a simple method of achieving continuous adjustments of frequency within ± 25-30 mc/s.

Apart from "Wismar" other measures were evolved to enable readings to be made within certain limits, even when the radar unit was being jammed. Among these was the "*Stendal*" (Hoffmann) procedure, by which the position of the jamming transmitter could be plotted with considerable accuracy and which was valuable as a guide to the searchlights. Furthermore, it was still possible, when jamming was not too powerful, to make active plots since the distance indicator was released only when the rotating dipole passed through the polarisation planes of minimum jamming field strength (Hoff-

mann ; " *Goldammer* ").[4] The importance of early, thorough work on anti-jamming methods was not demonstrated until two years later. The long-expected active jamming could almost always be successfully combated in the early days by the methods already introduced, above all by " Wismar ".

Alongside the problem of active jamming there was also the possibility of passive interference through the *dropping of artificial reflectors*. This is undoubtedly one of the saddest chapters in the history of German radar development. This danger, which had been recognised very early on (1939/40) and had been described in detail time and again, was given so little attention in higher circles that no counter-measures could be worked out in time. A test during the summer of 1942 proved that the radar instruments could be completely crippled by the dropping of even a small quantity of half-wavelength dipole foil (" Düppel " = English " Window "), and it was then thought that the way would at last be cleared for the development of counter-measures. On the contrary, however, all mention of this subject and all work on this project were forbidden, " so as not to give the enemy any inkling of this method of interference ". The catastrophic effect of this order began to be felt with the air raid on Hamburg on 24th July, 1943, when the A/A radar equipment was rendered completely helpless by the mass employment of " Window ". The consistent use of these tactics made radar plotting virtually impossible for some time afterwards. The complete surprise achieved by the British produced a serious loss of confidence in this most modern radar plotting apparatus among the totally unprepared troops.

The immediate withdrawal of the order prohibiting development of counter-measures led to a large number of experiments, developments and proposals. However, only two basic systems had reached the point where they could be used with some prospect of success.

The first method worked on the Doppler principle. It had already been so far developed by *Fack* in other connections (in 1940) that it could immediately be adopted in simplified form by A/A radar instruments. When this system was used aircraft echoes appeared as oval pulses amongst the irregular " window " reflections. The system was named " *Würzlaus* ", from the characteristic shape of the aircraft echoes. Even though the " anti-window factor " (ratio of target amplitude to " window " amplitude, when plotting was still possible) was only 1 : 3, this was a step forward. A short time later the auxiliary equipment was supplied to the units. It proved of valuable assistance, even though enemy jamming by means of " window " was generally in excess of 1 : 3 and accuracy of plotting was greatly reduced. The operation of the system was improved in the course of time, especially when it was brought in line with " Wismar ", and automatic control by means of the " *Tastlaus* " (Pöhlmann) was introduced. It was also used in conjunction with the longer-wave equipment of the German Air Signals Corps and the German Navy.

The second method was the addition of an acoustical instrument, the " *Nürnberg* ". Originally developed to pick up the " propeller modulations " contained in the reflection pulses, the acoustical instrument could be used in modified form to provide an audible check on the Doppler modulation of the aircraft.[5] This auxiliary equipment too was easily supplied. Thus it was possible to distinguish aircraft echoes from amongst powerful " window " jamming even when optical identification was impossible because of disturbances on the cathode-ray tube.

This principle was used by *Kettel* to develop a more comprehensive and considerably more efficient auxiliary instrument *(" K-Laus ")* with the aid of which the whole system of measuring and plotting was based on the isolated Doppler " sound ". With this apparatus, only a small number of which had been introduced by the end of the war, it was possible to obtain plotting accuracy almost equal to that of an undisturbed " Würzburg D ", even for a " window " ratio of 20 : 1. To enable the " K-Laus " to continue operating when the " window " was subjected to strong wind drift, an electrical method of compensating for the wind velocity (" Windlaus ") was introduced.[6] At that time Kettel's method was practically the only way of making existing radar apparatus " window "-proof. It was also to have been used for the " Mannheim " apparatus, whose plotting performance during " window " jamming was no different from that of the " Würzburg ", although the latter seemed to be capable of attaining almost the original standard of plotting with the aid of a specially adapted " K-Laus ".

Finally yet another aid, the " *Taunus* ", was introduced. Technically this was no more than a device to screen the images through a high pass filter. Although this did not basically eliminate the effects of jamming, it did in many cases produce a clearer reading which stressed the difference between " window " and aircraft reflections when the " Würzlaus " or " Tastlaus " systems were used.

At about the same time as word was received to go ahead on the development of anti-" window " measures, FAS III also began detailed investigations into the reflection properties of " window " (Slevogt, Wessel). Valuable information on reflection and broad band qualities was obtained, but it was soon realized that only a change-over to centimetre waves would provide any real solution, since then, for one reason, the beam could be made so narrow that disproportionate quantities of " window " would have had to be used to jam it effectively.

Although every conceivable effort was made to counter " window " jamming it was impossible to deny that these measures were but makeshifts and that the radar apparatus of the design and wavelength in use up to that time had lost their reliability and efficiency. Apart from the fact that the almost uninterrupted dispatch of new types of equipment to the widespread theatres of operations had a bad effect on the morale of the troops, the originally simple radar apparatus became more and more complicated to operate. The intensive use of " window " and jamming transmitters (with automatic change in frequency corresponding to changes in the frequency of the ground apparatus) made radar activity so difficult during the last stage of the war that useful plotting values could only be obtained in particularly favourable circumstances and by highly skilled operators.

In view of this situation it became necessary to use a system of *passive plotting* (D/F receivers " Naxos " and " Korfu ") with the aid of which the emissions of the enemy's 9 cm airborne radar equipment were used to plot the position of the aircraft. However, these instruments never attained the same importance in the A/A units as for the air raid reporting service, as they did not provide any method of determining the distance.

Final developments in the 50 cm band.

To make use of the advantages of sharper concentration of the beam so as to increase range and accuracy of plotting, and to ensure protection of the vital parts of the apparatus and the crews from air attack, the A/A Artillery gave instructions for the development *of the Fu.M.G.68 " Ansbach "*. This was the largest A/A radar unit that could be transported by road. It comprised the *operating car* containing the electrical measuring parts of the " Würzburg D " and a Leonard equipment of the type which had already been used for the servo control of the " Würzburg Giant ", on the one hand, and the *rotating stand with 4.5 m paraboloid* (fig. 4), connected to the operating car by means of HF cable and control leads, on the other. Range and plotting accuracy of the *Fu.M.G. 68* came fully up to expectations, but no tangible progress was made as regards freedom from jamming. The apparatus had the same mechanical precision as the " Mannheim " and " Würzburg Giant " and could therefore also be converted later to cm. waves. Finally it should be mentioned that the use of instrument indicators developed by the author enabled the Fu. M.G.68 to attain an even greater accuracy of plotting than was possible with the " Mannheim ".

[4] As the oscillations emitted by a dipole have a specific polarisation plane they are picked up most powerfully by a receiving dipole when the latter has the same arrangement in space as the transmitting dipole, i.e. is parallel to it. In all other positions reception is weaker and reaches a minimum when the polarisation planes of the two dipoles are at right angles to one another.

[5] The pulses reflected by propeller-driven aircraft appear with differing amplitudes in the receiver, a direct connection being distinguishable between the propeller r.p.m. and the variations in amplitude. A similar variation in amplitude occurs in the radar receiver when the Doppler principle is used. Its frequency (and consequently the pitch of the tone) depends on the wavelength of the radar unit and the radial velocity of the aircraft, i.e. on the speed at which the latter approaches or moves away from the radar post.

[6] As the principal advantage of the Doppler principle was that it enabled the observer to distinguish between moving targets (aircraft) and others (" window "), there was a risk of confusing aircraft and " window " reflections when the " window " was drifting rapidly in the wind. To avoid this was vital especially in units fitted with instrument indicators (" K-Laus "). Therefore, a new accessory, the " Windlaus " was introduced. With its aid " window " reflections were again shown as stationary targets-

As the Fu.M.G.68 was originally made only in small numbers and had no essential advantages over the types of apparatus already in use, it was not supplied to the units, but was immediately taken over for the 9 cm. " *Egerland* " which was developed in 1944.

In the spring of 1943 a new demand was made for a radar set of maximum range and best possible plotting performance, in connection with the development of the " Wasserfall " A/A rocket. Above all a high degree of constancy was required in view of the plan for beam guidance of the rocket. The exceeding of the permissible load factors of the rocket moving in the beam by the appearance of rapidly changing control impulses could not be permitted.

As a large number of experiments had already been made in this connection and a promising suggestion, a combination of the electronic lay-out of " Mannheim " with the " Würzburg Giant " (Prof. Weber), enabled tests to be carried out without additional strain on industry, a *Fu.M.G. 75* model was made by a special test section of FAS III. The " Würzburg Giant's " rotating stand was given an extra control post from which the target could be sighted and followed optically in line with the axis of the reflector. A synchronisation system permitted of smooth change-over from optical to electrical plotting (and vice versa). The apparatus was demonstrated five months later and was the first to provide the degree of accuracy—when free from jamming—originally required by the A/A Artillery. These values were just adequate for direct rocket guidance (because of special qualities) (cf. Table). The total mobile equipment weighed about 12 tonnes and the accuracy values were valid for speeds of flight of up to 850 km/h. Moreover a greater mean laying accuracy could be obtained with this apparatus (with optical sighting) than with the A/A Kommandogerät 40 fitted with the best gears.

Two Fu.M.G.75s were built by FAS III and made available for the rocket project. A fairly large series was to be made by Telefunken and to be attached, with anti-jamming equipment, to the large batteries guarding special ground targets.

Fig. 4 : The Fu.M.G. 68 " Ansbach " (53 cm wavelength), with separate rotating stand for 4.5 m reflector and operating car, was the largest mobile equipment attached to the A/A Artillery. The same operating car (" Bayern ") was later used for the 9 cm " Egerland " equipment.

The Development of Centimetre Instruments.

Theoretical experiments (Stepp, Wessel, Slevogt) had proved that the use of cm. wavelengths and utilisation of very sharp beams would result in a marked reduction in susceptibility to jamming. An extremely costly experiment with radar apparatus of 9 cm to 2.4 m wavelengths with jamming by means of strips of metal foil of various lengths confirmed this view. A 9 cm. set working with a 3 m. reflector even gave a better anti-" window " factor than the " Würzburg D " with " K-Laus ".

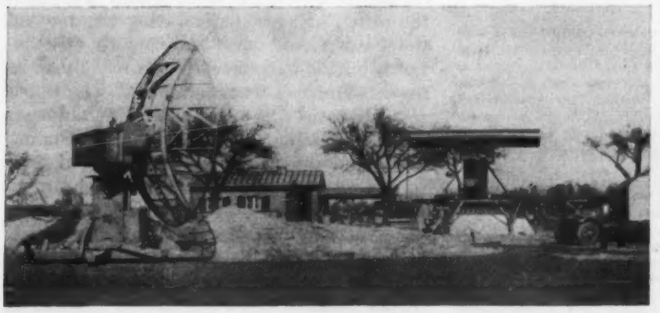
The decisive test was made by Telefunken and FAS III on 22nd December, 1943. A 9 cm Rotterdam (H2S) apparatus fitted provisionally on a " Mannheim " rotating stand gave a range of 30 km, whereas an earlier test on the same day with a reflector 0.8 m. in diameter had produced a range of 8 km.

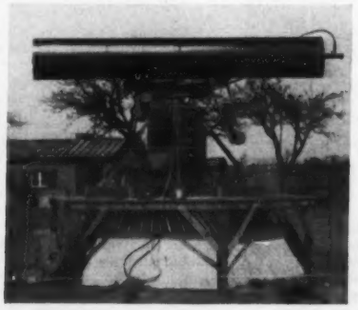
This was the beginning of the development by Telefunken of the " *Egerland* " A/A radar unit. At first the prototype of an A/A radar unit, working on a 9 cm. wavelength, was produced at FAS III and fitted, for accurate plotting, with a defocussed, rotating dipole and the " Würzburg D " measuring unit. This apparatus at once produced surprisingly good results. Plotting accuracy was in part greater than that of the " Mannheim ", and the target could be followed almost without disturbance even during powerful " window " jamming (against 50 cm. waves). Further tests seemed to open up prospects of a fundamental solution of the anti-jamming problem.

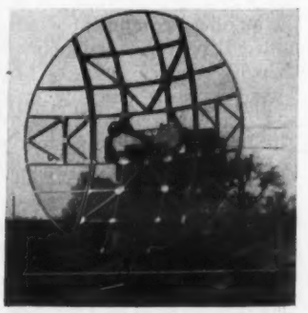
As the " Egerland " equipment could not be ready for general service until the beginning of 1945 and as radar plotting was meanwhile becoming more and more hopeless, the C. in C. of the A/A Artillery requested that a number of key points be equipped with provisional centimetre radar sets. A small series of the above-mentioned experimental models went into production under the name of *Fu.M.G. 77* " *Marbach V* ". Close cooperation between the Telefunken group and FAS III enabled the first four sets of this model to be completed within six weeks of the placing of the order. Here too the mechanically outstanding " Mannheim " rotating base with its speed-controlled gears was used. The normal UHF unit was replaced by the 9 cm (SHF) unit from the airborne " Berlin " radar instrument and the measuring and indicator parts from the " Würzburg D ". The beam was produced by a rotating dipole of Telefunken design. One of these instruments was captured during the Allied advance into Germany and sent to the British radar research centre.

The first two " *Egerland* " *units* were completed a few months before the end of the war (figs. 5 to 7). They consisted of the *Fu.M.G.74* " *Kulmbach* " omni-directional search apparatus (fig. 6), the *Fu.M.G.76* " *Marbach* " fire-control apparatus (fig. 7) and the " *Bayern* " *operating car* (fig. 4). This equipment at last met the tactical and technical requirements laid down in 1939, that every A/A battery should be equipped with *two* radar instruments, one an early warning apparatus to keep a constant watch

Figs. 5-7 : The extremely accurate " Egerland " A/A equipment (9 cm wavelength) comprised the Fu.M.G. 74 " Kulmbach " omni-directional search apparatus (centre) with cylindrical reflector, the Fu.M.G. 76 " Marbach " fire control apparatus (right) with 4.5 m. reflector and the operating car seen in fig. 4. Distance accuracy ± 30 m ; laying accuracy for angular height and azimuth 1/16°. (First publication — Strictly copyright by INTERAVIA S. A. — Geneva.)







on the air space and locate the target, and the other to provide fire control values. It is worthy of mention because it was in many respects just as good as, if not better than the Allied apparatus in use at the end of the war.

The " Kulmbach " omni-directional search apparatus had a cylindrical reflector rotating at 20 r.p.m., whose angle of elevation could be remotely controlled during search operations. The target was shown on a normal PPI (panorama) scope which also indicated the position of the target in relation to the map. Above the PPI-scope was the direction indicator giving the azimuth values for the " Marbach ". The " Kulmbach " indicators and the " Marbach " measuring unit were installed in the operating car, which could be dug in or otherwise protected from air attack. The SHF unit also came from the " Berlin " airborne instrument and was installed, so as to keep the high frequency feed line as short as possible, in the base of the " Kulmbach " stand. Only the image content was transmitted to the operating car, and there were also other LF control leads.

The " Marbach " fire-control apparatus used the rotating base and the remote-control system of the Fu.M.G.68 practically unchanged. The SHF unit (" Berlin " as well) was fitted in two boxes immediately behind the reflector so that only LF signals had to be transmitted by cables to the operating car. The latter contained modified units from the " Würzburg D " for indicating distance measurements and plots, viz.: — one screen for the whole area scanned, and others showing an enlarged section of the area, for plotting azimuth angular height and distance.

In front of the azimuth operator there was an auxiliary scope with the aid of which the " Marbach " reflector could be swung within a matter of seconds into the direction of the target as indicated on the panorama screen of the " Kulmbach ". The elevation value passed to the " Marbach " (which had an extremely sharp beam—approx. 2°) was only a rough one, correct to within a few degrees. This however was accurate enough to enable the target identified by the " Kulmbach " to be picked up rapidly after small corrections. Tests carried out near Berlin during the spring of 1945 proved the efficiency and reliability of this arrangement. For example during mass raids, immediately one target was correctly plotted another one was sought, and it was found possible to plot up to seven different targets within a minute. The range of the " Kulmbach " was approx. 30 km, and that of the " Marbach " about 50 km. It was planned to increase the range of the " Kulmbach " up to that of the " Marbach " (by raising the transmitter power from 10-15 kW to 100 kW).

The use of these two instruments in conjunction with one another was found to be highly satisfactory, especially in cases of powerful " window " jamming. Although the directional selectivity of the " Marbach " itself permitted of accurate target plotting, the early warning provided by the simultaneously operating " Kulmbach " was of valuable assistance. Finally it was also planned to introduce the " K-Laus " into the " Egerland " equipment, which would have rendered it practically immune from " window " jamming.

Checking and calibrating methods.

In view of the high degree of accuracy required from radar apparatus, suitable checking devices had to be evolved. For *range plotting* use was made of the *optical time base*, whose accuracy is of the order of metres.[7] This at the same time made checking of azimuth and angular height possible, since the whole path of the target could in general be represented graphically from the time base values. With this method however, it took several hours to complete the necessary film interpretation, calculations and drawings. It was therefore necessary to provide a system of *checking plots* that would give constant and immediate results. The equipment developed by FAS III (Prof. Wever) for this purpose compared electrically, in a phase and amplitude-sensitive bridge, the optical laying values of the Kommandogerät with the plotting values from the radar apparatus, and recorded the results. By this means not only momentary errors but also constant mean deviations could be recognised and the constancy of measurements gauged in the simplest possible manner. Figs. 8 and 9 show such measurements for the " Würzburg D " and " Marbach V ". Further experiments specially designed to test the mechanical properties of the gears were carried out, using a gyroscopic accelerometer.

So that the distance calibration could be checked at any time, artificial reflections were produced by means of a delay instrument, which simulated a distant target whose " distance " could be determined very accurately. This artificial target ("Rehbock ") could at the same time be set up in front of the reflector of the radar unit so that an exact check of the beam as regards the mechanical axis of the reflector could also be made.

[7] Two theodolites several miles apart followed the target. The elevation and azimuth values at given moments were photographically recorded and then, after conversion, represented graphically. This gave the track of the target with all its values.

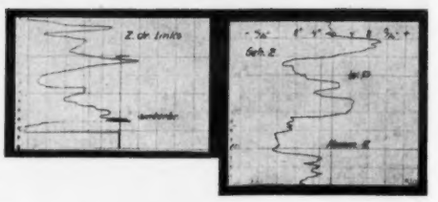


Fig. 8 : Results of plotting checks on the Fu.M.G. 39T " D " " Würzburg " : left, the results of azimuth plots; right, those of angular height plots; bold line denotes 4/16° plotting error.

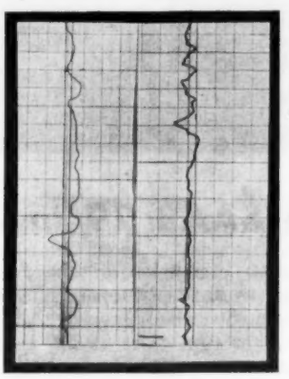
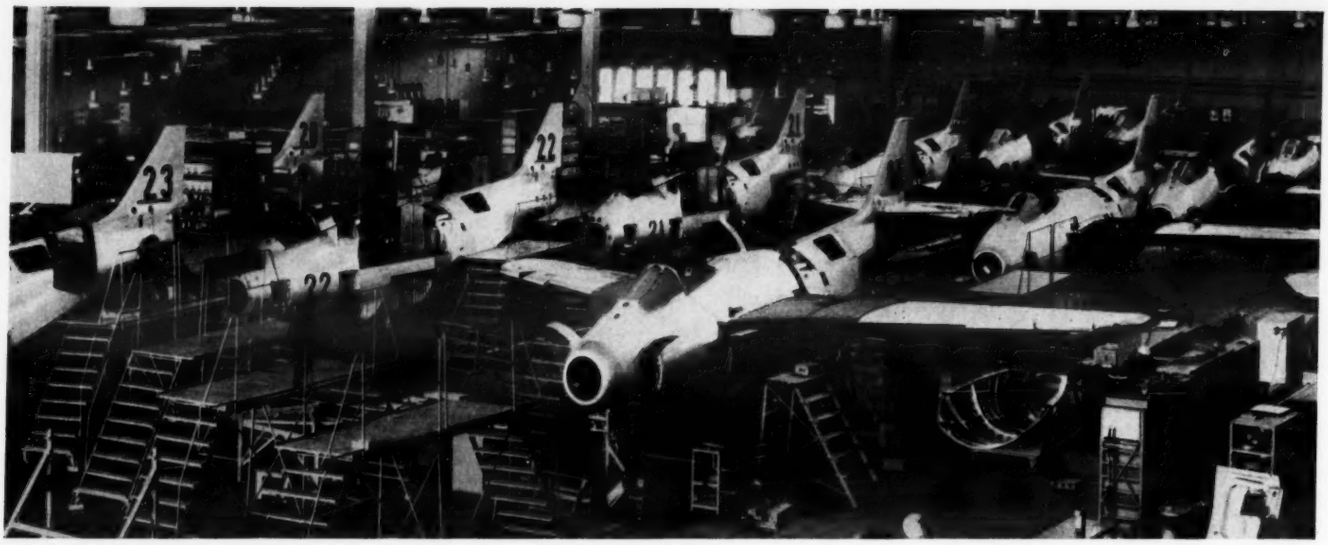


Fig. 9 : Results of plotting checks on the Fu.M.G. 77 " Marbach V " : left, results of azimuth plots; right, those of angular height plots; bold line denotes 4/16° plotting error.

Type of Apparatus	Code Name	Year	Wave-length (cm)	Output (kW)	Diameter of reflector (m)	Range (km)	Accuracy Bearing (1/16°)	Accuracy Range (m)	Accuracy Height (1/16°)
Fu.M.G.39L [1]	—	1939	62	2	2.4	10-15	± 32-48	± 40-50	± 48-64
Fu.M.G.40L	—	1940	53	50	2.4	25-40	± 10-12	± 30-40	± 10-12
Fu.M.G.39T " A " [1]	Würzburg A	1940	53	8	3	20-30	± 24-32	± 80-120	± 24-32
Fu.M.G.39T " D "	Würzburg D	1941	53	8	3	20-30	± 5- 8	± 30-40	± 7- 9
" D " with " K-Laus "	Würzburg D	1944	53	8	3	20-30	± 8-10	± 30-40	± 6- 8
Fu.M.G.65	Würzburg Giant	1940	53	8	7.5	40-60	± 2.5-3	± 30-40	± 1.8-2.5
Fu.M.G.HIT	Mannheim	1942	53	16	3	25-40	± 2.5-3	± 15-20	± 2.5-3
Fu.M.G.68	Ansbach	1943	53	8	4.5	30-40	± 2.3[2]-3.5	± 30-40	± 1.6[2]-3.5
Fu.M.G.75	Mannheim Giant	1943	53	16	7.5	50-70	± 1.5 [3]	± 15-20	± 0.8 [3]
Fu.M.G.77	Marbach V	1944	9	10-15	3	25-35	± 1-2	± 25-35	± 1-2
Fu.M.G.74	Kulmbach	1945	9	10-15	—	20-30	—	approx. 300	—
Fu.M.G.76	Marbach	1945	9	10-15	4.5	30-50	± 0.7-1	± 25-35	± 0.7-1

[1] Without beam D/F (Fu.M.G.39 L and Fu.M.G.37 T " A ").
[2] Values in brackets refer to instrument indicators.
[3] Values of ± 0.3/16° (for bearing) and ± 0.06/16° (for height) were obtained, for optical sighting of the Fu.M.G.75.



The SAAB 29 in Quantity Production

Quantity production of the SAAB 29 single-seater high performance fighter has started at Svenska Aeroplan A.B.'s Linköping plant. An order for 500 aircraft for the Swedish Air Force is to be completed by 1954. The development, construction and flight testing of three prototypes and a pre-production model cost roughly 30,000,000 kroner. — Our picture shows final assembly of the first production models. The SAAB 29, one of the most up-to-date of jet fighters (described in detail in INTERAVIA, Review of World Aviation, No. 7, 1951), is to go into service with the Kungl. Bråvalla Flygflottilj fighter squadron.

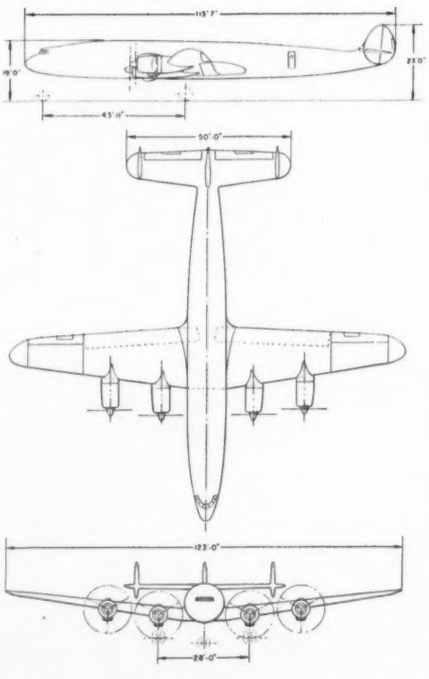
From "Constellation" to "Super Constellation"

During the almost ten years it has been in service the four-engined Lockheed " Constellation " has won an international reputation. Airlines all over the world use it regularly, it has crossed the Atlantic tens of thousands of times and is a common sight in North and South America, Africa, Australia and the Near and Far East. Today the mighty monoplane, with its characteristic triangular fin, is to be seen at all international airports. Tomorrow will bring little change. A bigger, faster and more economic " Super Constellation " is flight testing.—The " Constellation " is growing.

*

The original design of this most successful aircraft type dates from before the war. The first studies were undertaken by the *Lockheed Aircraft Corporation* in June 1939 at the instigation of Trans World Airline. The project was in the hands of Charles L. Johnson, and the type was designated L-49. The basic data promised a fast, economical aircraft. It was expected to have a useful load of 5,500 lbs. and the considerable—for those days—range of over 3000 miles.[1]

[1] The history of the " Constellation " (up to the L-649 series) was described in this Review five years ago; cf. INTERAVIA Review of World Aviation, Vol. 1, No. 1, April 1946.



Lockheed L-1049 " Super Constellation ".

Pan American Airways were next to order the new aircraft. Then the U.S. Department of Defense began to show interest in it, and after America's entry into the war the L-49 became the C-69 military transport. A first prototype (XC-69) was flight tested in January 1943. Although originally designed for peaceful purposes, the first " Constellation " thus bore the white star of the U.S. Air Force. Quantity production of the C-69 started up. By April 1944 the U.S.A.F. was able to put the first production model into service, and this was followed by two others during the same year. By the end of the war there were fifteen in service. A modest number perhaps —but Lockheed, then as now, was primarily a producer of experimental aircraft and fighters.

It was thus not until after the war that the " Constellation " could be used for its original purpose. First a number of surplus C-69s were converted for civilian use. There was no lack of customers for these. At the same time quantity production of the L-49 [2]

[2] Characteristics of L-49: Power plant: four 2200 h.p. Wright R-3350-31 " Cyclone 18 " double radials. Span 123 ft., aspect ratio 9.7, wing area 1.650 sq. ft., length 95 ft. 1 in., gross weight 86.250 lbs, fuel capacity 4.650 U.S. gals. The L-49's wing, an almost geometrical enlargement of the " Lightning's " wing, has been retained, with no change to outward form or principal dimensions, in all subsequent versions. It is being used again in the " Super Constellation ".

also got under way. Including the converted C-69s, a total of 88 aircraft were supplied to PAA, TWA, Panagra, Eastern Air Lines and others.

*

Encouraged by this success Lockheed carried development further. A number of intermediate versions (in particular the L-149 and L-549) were followed by the L-649, which embodied marked improvements over the original model. More powerful engines (2500 h.p. Wright R-3350-C.18 BD-1) and structural reinforcements enabled the gross weight to be increased by roughly 10%. The L-649 was also the first of the series to have a " Speedpak " freight container suspended beneath its fuselage. This gives an increase of 7,500 lbs, in the useful load—at the expense of a slight reduction in range.

At brief intervals there followed the L-749 and L-749A, two improved versions which are in operation with quite a number of airlines today. These have a still higher gross weight and wings modified to take auxiliary fuel tanks. The result is a considerable gain in range without any loss in useful load.

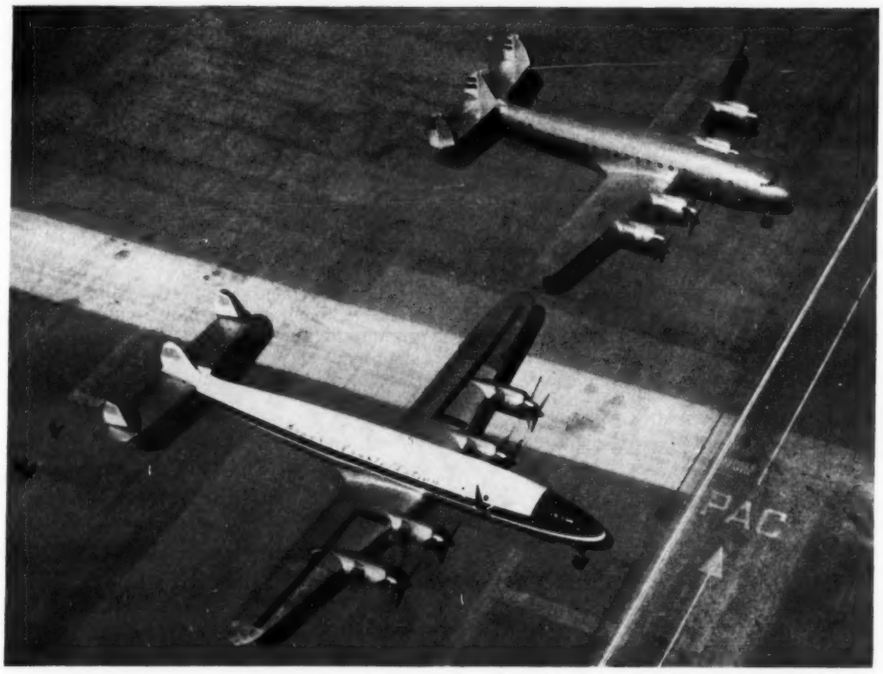
With the L-749 and L-749A it began to look as if development of the type had reached its limits. Experiments were made with still more powerful engines, the 2700 h.p. Wright R-3350-C.18 CA-1 (L-749B), but this plan was dropped, since the airframe was found to be too small to enable full advantage to be taken of the increased engine power. Lockheed therefore turned to the idea of raising the useful load by increasing the length of the fuselage. The first step towards the L-1049 " Super Constellation " was taken.

*

Strangely enough, the XC-69, the first prototype of the whole " Constellation " family, was used as a basis for the L-1049 experimental model. To get the desired increase of 18 ft. 4¾ in. in fuselage length, the XC-69's fuselage was chopped in three, and an extra sector inserted fore and aft of the junction of the wing spars. Wing joints, undercarriage and engine supports were strengthened, but wings and tail unit were retained practically unaltered.

The L-1049 prototype, which reached the flight testing stage in October 1950, was followed by the first production model with all the latest improvements. More efficient cabin pressurization and large rectangular windows increased passenger comfort, and the new type of electrical system and an electro-hydraulic anti-icing system give improved safety.

*



Comparative size : Apart from the fuselage, which is 18 ft. 4¾ in. longer, the " Super Constellation " has the same principal dimensions as the " Constellation ".

Scarcely had the " Super Constellation " prototype completed its first flights than Lockheed announced a number of sub-versions. In addition to the military versions (Air Force and Naval Aviation), the following types have so far appeared : *L-1049B freighter* (*3250* h.p. Wright R-3350-TC.18 DA-1 " Turbo-Cyclone 18 " compound engines) ; *L-1049C passenger version* (also with compound engines) ; *L-1049D freighter* (propeller turbines). With respectable orders behind them,[3] Lockheed are evidently planning to make the " Super Constellation " into more than a freighter and transport for today alone. There is much to indicate that development is to continue. Unless present appearances are deceptive, the L-1049, which is at present fitted with piston or compound engines, is later to have propeller turbines and finally to serve as transition to a jet-powered transport.

[3] The U.S.A.F. and the U.S. Navy have placed large orders for the C-121C (U.S.A.F.), R70-1 and PO-2W (both Navy types) ; exact numbers involved have not been revealed, however.

COMPARATIVE DATA	Lockheed L-749A " Constellation "	Lockheed L-1049C " Super Constellation "
Power Plant		
Engine type	Wright R-3350-C.18 BD-1 " Cyclone 18 "	Wright R-3350-TC.18 DA-1 " Turbo-Cyclone 18 "
Take-off power	2500 h.p.	3250 h.p.
at	2800 r.p.m.	2900 r.p.m.
height	3800 ft.	—
Max. continuous power	2100 h.p.	2600 h.p.
at	2400 r.p.m.	2600 r.p.m.
height	4400 ft.	15,000 ft.
Fuel capacity	5820 US gals.	6570 US gals.
Propellers	Hamilton-Standard or Curtiss-Electric, 3-blade	—
Diameter	15 ft. 2 in.	
Principal dimensions and weights		
Span	123 ft.	123 ft.
Length	95 ft. 1 in.	113 ft. 7 in.
Height	23 ft.	23 ft.
Wing area	1650 sq. ft.	1650 sq. ft.
Aspect ratio	9.7	9.7
Max. take-off weight	107,000 lbs.	130,000 lbs.
Max. landing weight	89,500 lbs.	105,000 lbs.
No. of passengers	44 to 64	47 to 103

	Lockheed L-749A " Constellation "	Lockheed L-1049C " Super Constellation "	
Performance			
With take-off weight of		130,000 lbs.	105,000 lbs
Max. speed	347 m.p.h.	362 m.p.h.	374 m.p.h.
Cruising speed	298 m.p.h.	305 m.p.h.	335 m.p.h.
height	20,000 ft.	20,000 ft.	20,000 ft.
Landing speed	91 m.p.h.	—	—
Rate of climb			
at sea level			
with four engines	1234 ft/min	1195 ft/min	1880 ft/min
with three engines	640 ft/min	580 ft/min	1040 ft/min
Service ceiling			
with four engines	25,000 ft.	23,200 ft.	27,600 ft.
with three engines	20,000 ft.	18,000 ft.	23,000 ft.
Take-off run to clear 50 ft.			
at sea level	3680 ft.	4300 ft.	2450 ft.
Landing run to clear 50 ft.			
at sea level	2880 ft.	—	3180 ft.

"Mercator" Air Navigation Computor

by WILLIAM D. FORSSMAN, K.L.M.

A by-product of man's relentless pioneering into the realm of speed is the labour saving device. Within the field of air navigation, or " Avigation " as our American colleagues feel it should be called, where advances in aircraft speeds have cramped the style of the navigator due to the contracted time lapse between ports of call, the time and labour saving calculator or computor has achieved the stature of indispensability. Here again, necessity is the mother of invention. Amongst examples which are standing the test of time, the Dalton Dead Reckoning Computor commands a prominent place.

A newcomer which has recently appeared on European markets and which should promptly merit popularity with exponents of the science, is the " Mercator " B-3 computor. In basic design this computor is similar to the Dalton. It does however incorporate many refinements which modern, up-to-the-minute airline operations have created an urgent need for. The " Mercator " was conceived and produced by private interests in the Netherlands. Technicians of K.L.M. Royal Dutch Airlines contributed ideas, advice and practical assistance from their extensive experience in this field.

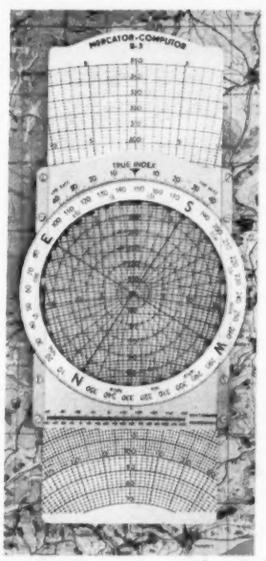
The accompanying photographs illustrate the similarity of this computor to the Dalton. The speed slide is slightly longer, but all other dimensions remain much the same. The " Mercator " is of all-metal construction, except the face of the rotatory compass rose, which has been made of transparent plastic material. The metal used is a light-weight aluminium alloy commonly known as Dural. All surfaces are super hardened by a special process. Pencilled notes on the surfaces show up promptly and clearly, but are readily removable with a damp finger. The printing is chemically engraved into the metal in clear, readable type.

Whilst currently much of ICAO's energy is being directed towards international standardisation of dimensional units, the need for simple and rapid methods of conversion constantly makes itself felt during the air navigator's daily practice. The " Mercator " fulfils this requirement adequately. Unit conversions readily available without pre-determined formulae or ratios include Centigrade/Fahrenheit, millibars/inches Hg., nautical miles/statute miles/kilometres, feet/yards/metres, Imperial gallons/U.S. gallons/litres, lbs/kg. A unique arrangement makes provision for direct conversion of volumetric units, i.e. gallons and litres, into weight units (lbs. or kg.), through the full range of specific gravities normally appertaining to aircraft fuels.

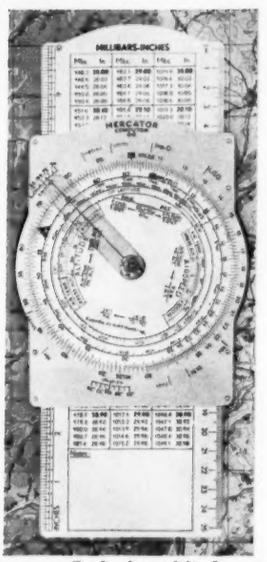
The circular slide rule configuration is similar to that of the Dalton except that it provides not only altitude and airspeed correction, but also simplified solutions to Point of No Return, Point of Equal Time and Altimetry (Pressure Pattern navigation) problems. The latter are ingeniously presented and remarkably easy to negotiate. Another improved feature is the hours scale, which runs up to 20 hours instead of the usual 10.

As a result of improvements to the face of the rotatory compass rose, solution of vector problems is a more straightforward process with the " Mercator ". These improvements are firstly, wind velocity circles drawn concentric to the grommet and secondly, wind direction lines radiating from the grommet to the perimeter of the face. These two features allow direct reading of all other parameters of the vector problem, once heading and airspeed or track and ground speed have been set.

The " Mercator " B-3 computor constitutes a noteworthy and commendable contribution to an all important facet of aviation progress.



Front : Compass rose with wind direction lines and wind velocity circles ; slide for aircraft speeds.



Reverse : Scale for altitude, speed, time of flight ; conversion from English to metric system.

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To our readers and subscribers !

During the past twelve months we have had to contend with constantly rising prices for both paper and printing. We have been reluctant to pass on any of this increase to our readers, but now unfortunately find ourselves unable any longer to avoid increasing our rates for both single copies and subscriptions.

The increase for the time being is to be a modest one. It will be effective from December 1st, 1951.

New rates : Country	12-month subscription	6-month subscription	Single copy
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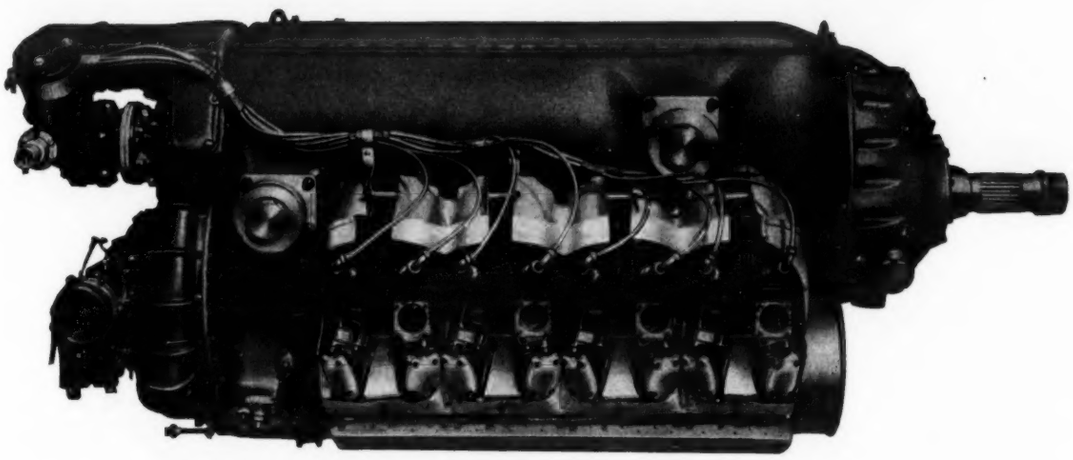

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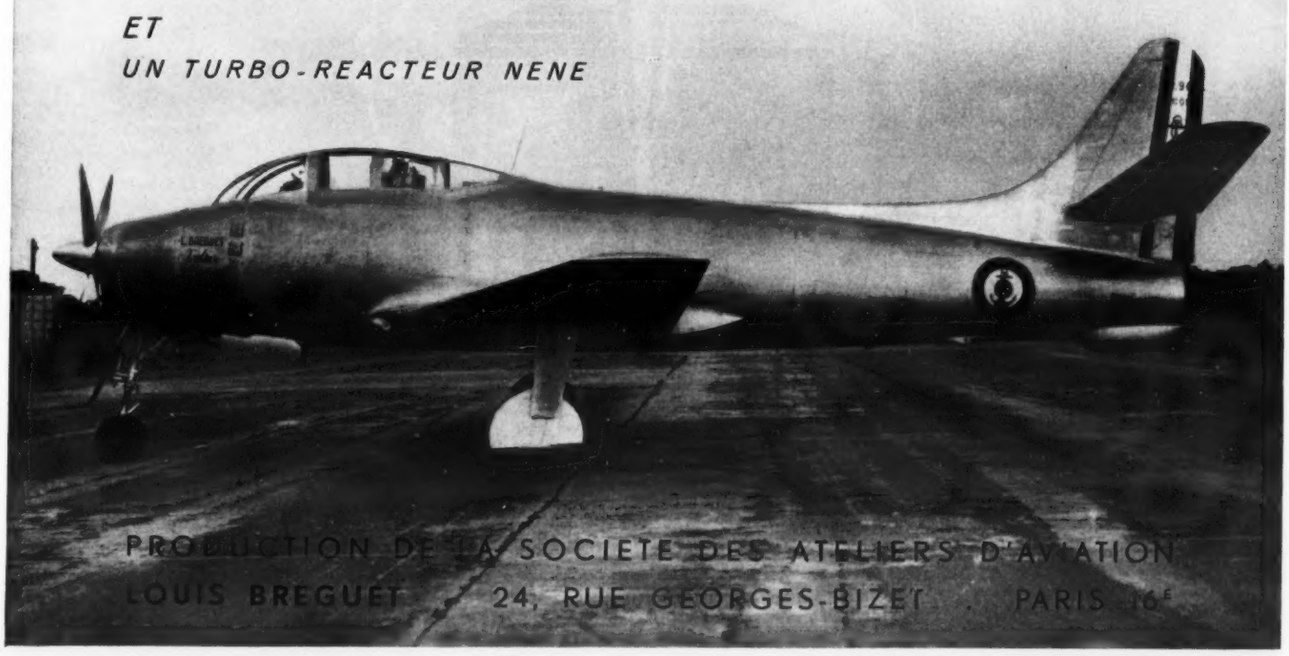

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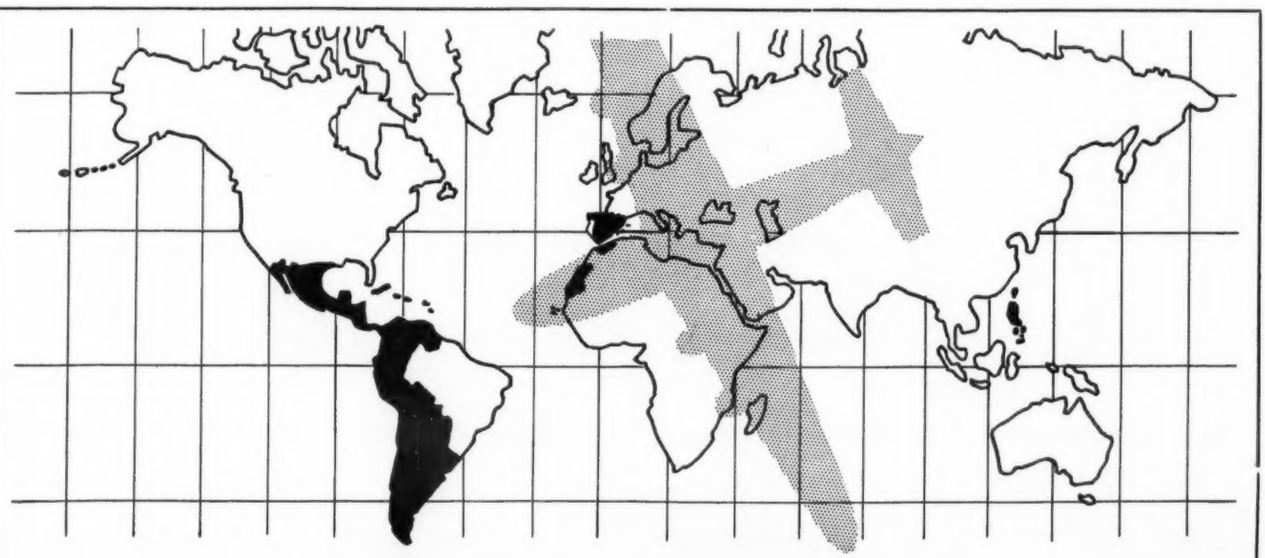

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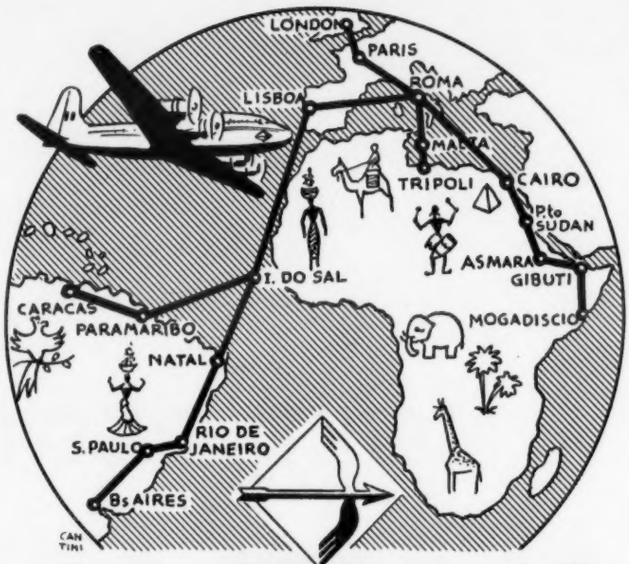

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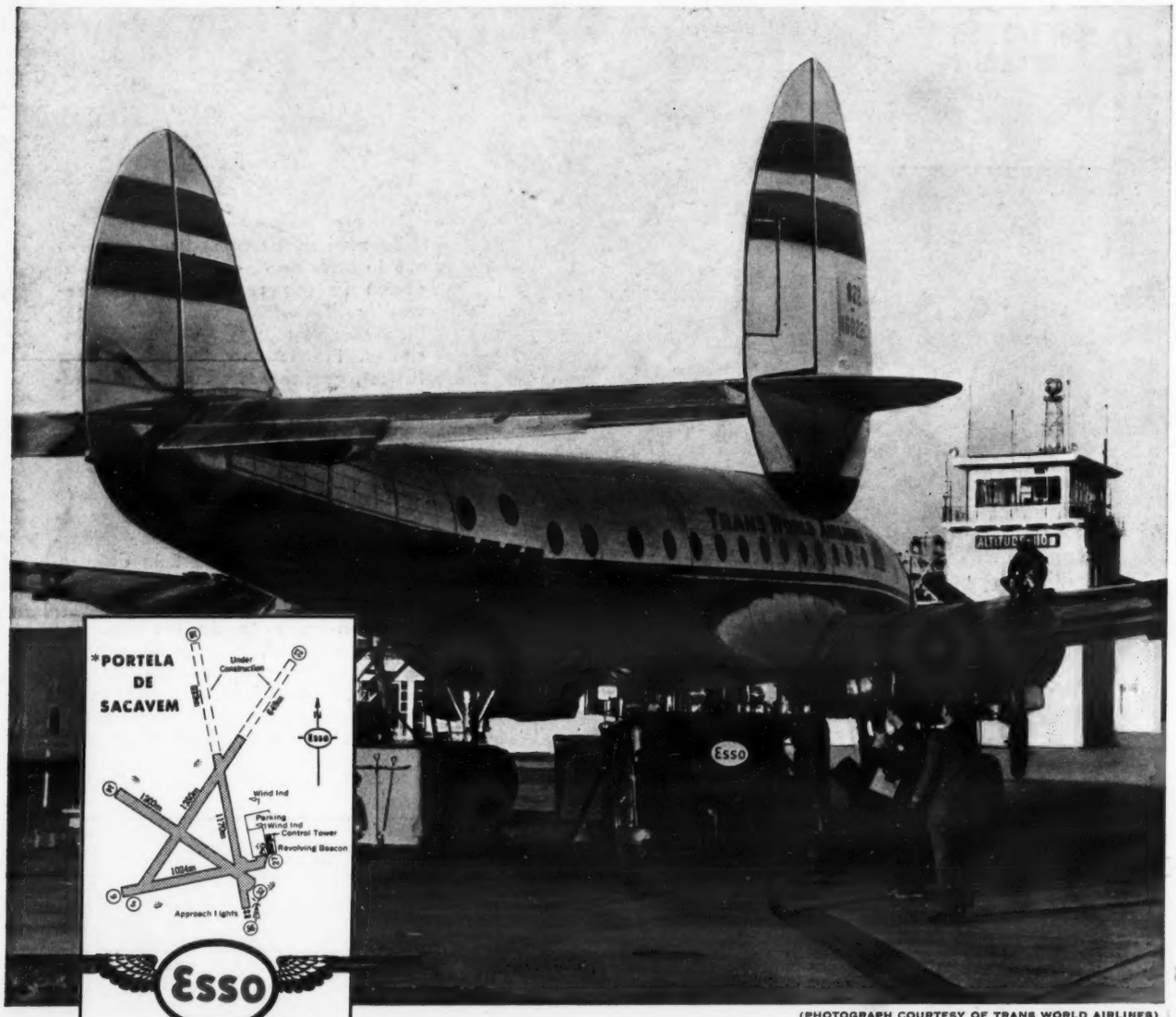

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